The WHAT'S NEW magazine

APRIL 1987

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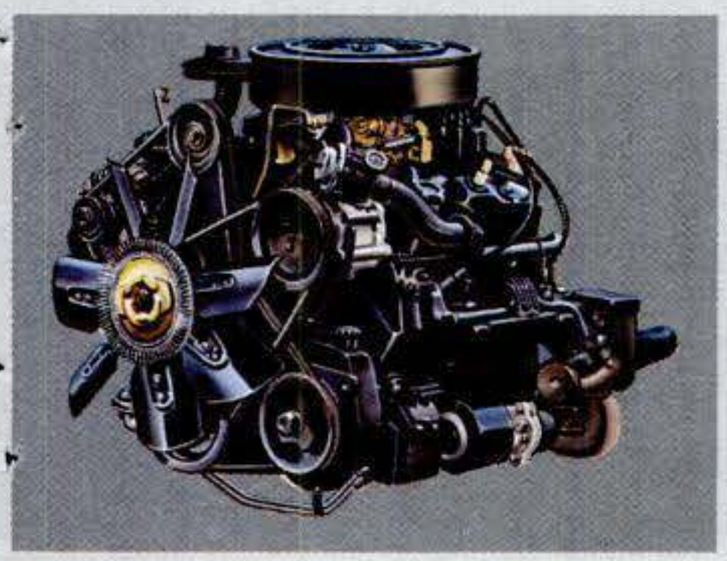

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APRIL 1987
Founded in 1872/Vol. 230, No. 4

Tomorrow's airliners

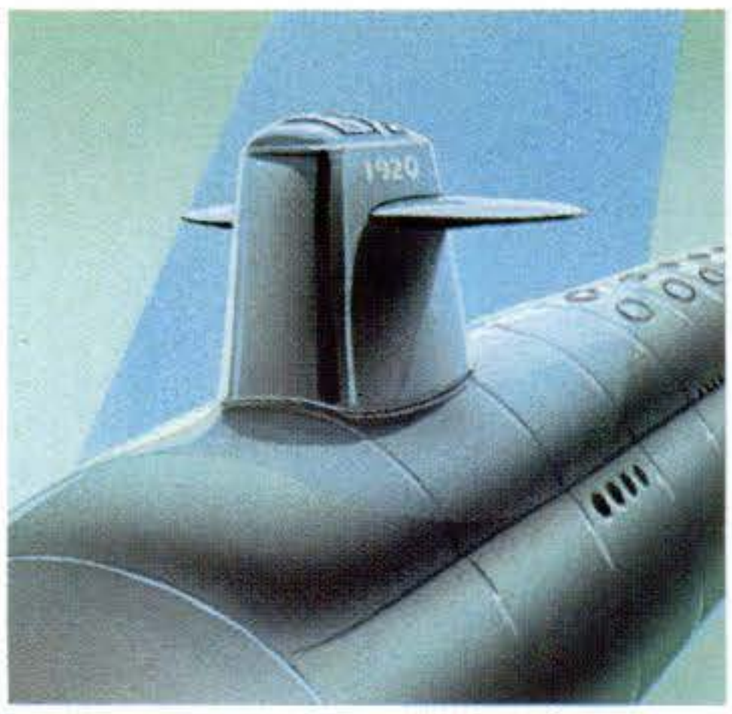
Besides propeller blades on rear-mounted engines, next-generation airliners won't look that different from today's. On the inside, however, advanced systems will make the planes safer, cheaper, and more comfortable. **Page 49**

Elegant decks

Your backyard's terrain and house's style will determine which of our two designs is for you. Both add an "outdoor room" and are built to last. **Page 60**

Signaling subs

Navy submarines must surface to receive communications, but such action can give away their strategic positions. Now subs can stay hidden longer, receiving low-frequency radio waves from transmitters. Eventually, subs may get all their signals from laser-beaming satellites. **Page 44**



The British are coming!

The Sterling is a strong rival to the Mercedes 300E and Cadillac Seville. But what mix of performance, quality, and comfort makes a car worth over $25,000? **Page 28**

What's New Digest 86–96

Science and Technology

Science newsfront 8
Turbine turn-on 38
Signaling subs 44
Self-cooling cans 53
Cold fusion 54
Super still 56
What's new—products and technology ..86
Ultra-sensitive blood test 104
Stair-climbing wheelchair 108

Space and Aviation

Engineering tomorrow's airliners 49

Computers and Electronics

Electronics newsfront 22
What's new in electronics 90
Hide-and-speakers 102

Cars and Driving

Automotive newsfront 18
Car test: The British are coming! 28
What's new for your car 94

Recreation

What's new in recreation 88
EOS: fast, quiet auto SLR 114

Home, Shop, and Yard

ANNUAL SPRING HOME-IMPROVEMENT SECTION

Elegant decks—low or high 60
Optical fire spotter 65
Plastic nails 66
Cop in a box 68
Wiring tips from the pros 71
Paneling in unexpected places 72
Whole-house fan 76

PLANS AND PROJECTS

Remodeling woes? 83
6 steps to keep garage doors rolling 84
Plumb-bob shortcut 110
Wiring adapter for a trailer hitch 110

TOOLS AND TECHNIQUES

What's new in tools 96

CAR CARE

"Say Smokey—" 16
Taking care of your car 116

Additional Features

Readers talk back 4
What's news 43
Wordless workshop 112
Product information 132

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Readers Talk Back

Supercharged Studebakers

I'd like to comment on your January article on supercharging. I don't recall any American Motors cars that were equipped with superchargers, but how could you fail to mention the one company that *did* make quite a bit of use of the device? To refresh your memory, Indiana's own Studebaker offered superchargers on Golden Hawk hardtops and Packard sedans and wagons in 1957 and 1958, and on the Packard Hawk in 1958. In 1963 and 1964 the company also offered the same basic unit, called the Paxton, which was used on two of the four engines that were available in the Avanti —as well as for Gran Turismo Hawks and Larks that were purchased with Avanti engines.

Gordon Y. Mills, Upland, Calif.

Choosing technology

Robert R. Bullard's letter, Death Technology ["RTB," Jan.], was terribly shortsighted. In the name of social responsibility he'd put the U.S. and its allies at risk by ceasing development in the only area in which we retain a clear lead over the Soviets: military technology. Unilateral surrender aside, we don't have a choice in deciding whether to counter the massive Soviet arms buildup. We do have a choice, however, between quantity or quality of defensive arms. Would it be socially responsible to mortgage our children's future by reliance on obsolete defenses?

E. W. Sharadin
Mountain Home, Idaho

Mini-wagon mismatch

I find it difficult to understand why you included the Subaru four-wheel-drive turbo GL10 station wagon in the article "4WD Mini-Wagons" [Dec. '86]. I have nothing against the Subaru wagon; in fact, I presently own a 1986 GL 4WD Subaru wagon. It's just that the cost of the turbo model is much higher than that of the other wagons tested and, at least in my driving area, not as popular as the basic Subaru GL model, which seems more in line with the price of the other 4WD wagons tested. Also, if the non-turbo Subaru had been tested, I think your acceleration results would have shown a marked change to the lower end. The other Subaru 4WD wagons have engines with carburetors, with a much lower horsepower rating, and have problems passing and climbing mountains and steep hills.

Stan Kalishman, Rochester, N.H.

"You aren't the only one who noticed the price disparity in that test. Unfortunately, press vehicles are frequently well-optioned to show off company hardware."—Jack Keebler

Engine virtuoso

As an owner of a 1981 Mazda RX-7, I must make a rebuttal to the January car test. Since when does the sound have anything to do with quality and performance of an engine? You state that the Mazda's rotary engine "has a harsh mechanical tone . . . " There has never been an auto piston engine as smooth as the rotary. True, it sounds different, but that's just a characteristic of the rotary; isn't different sometimes better?

Harold Nix, Newark, Ark.

Thumbs down for heads up

Speaking as a professional engineer with more than 40 years of systems experience, I am genuinely shocked by the statement that lengthy and tedious pre-mission training will not be needed if NASA space-station astronauts are outfitted with a headband-mounted TV monitor/laser-disc device ["Science Newsfront," Dec. '86]. The space station will represent highly sophisticated technology, and it is reasonable to expect that it be operated and maintained by highly trained technologists with enough experience to be intimate with their equipment. In the event of critical emergencies requiring immediate action or failure of the TV prompter system, I'd rather put my money on technicians who have had detailed, lengthy, and, yes, tedious pre-mission training.

James W. Creson, Ph.D., P.E.
Mountain View, Calif.

Correction: The price of the Yankee Spirit window ["What's New in Home Improvement," Dec. '86] is $1,500. PS

Address letters for this column to: Readers Talk Back, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. We are unable to acknowledge unpublished letters.

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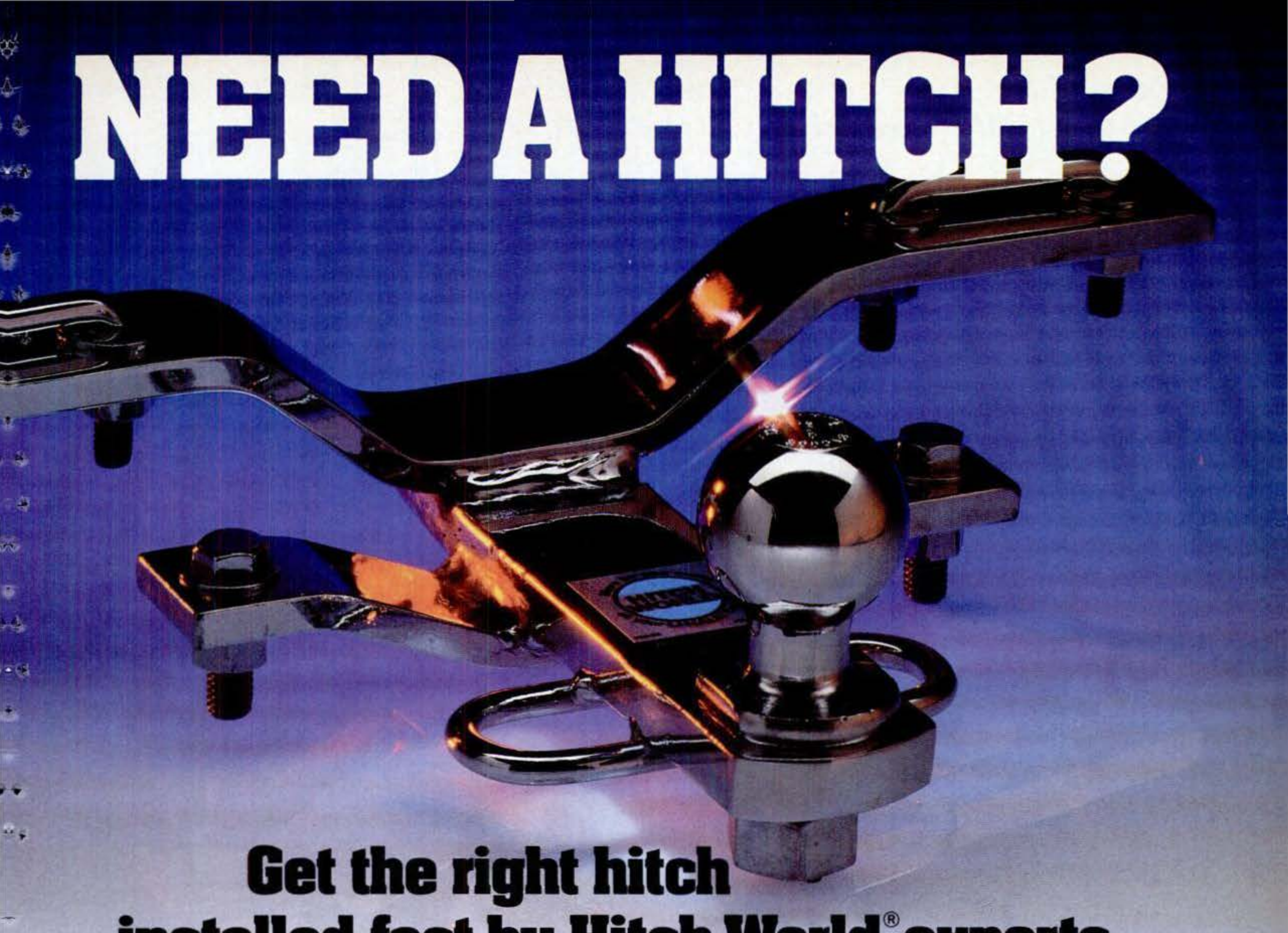

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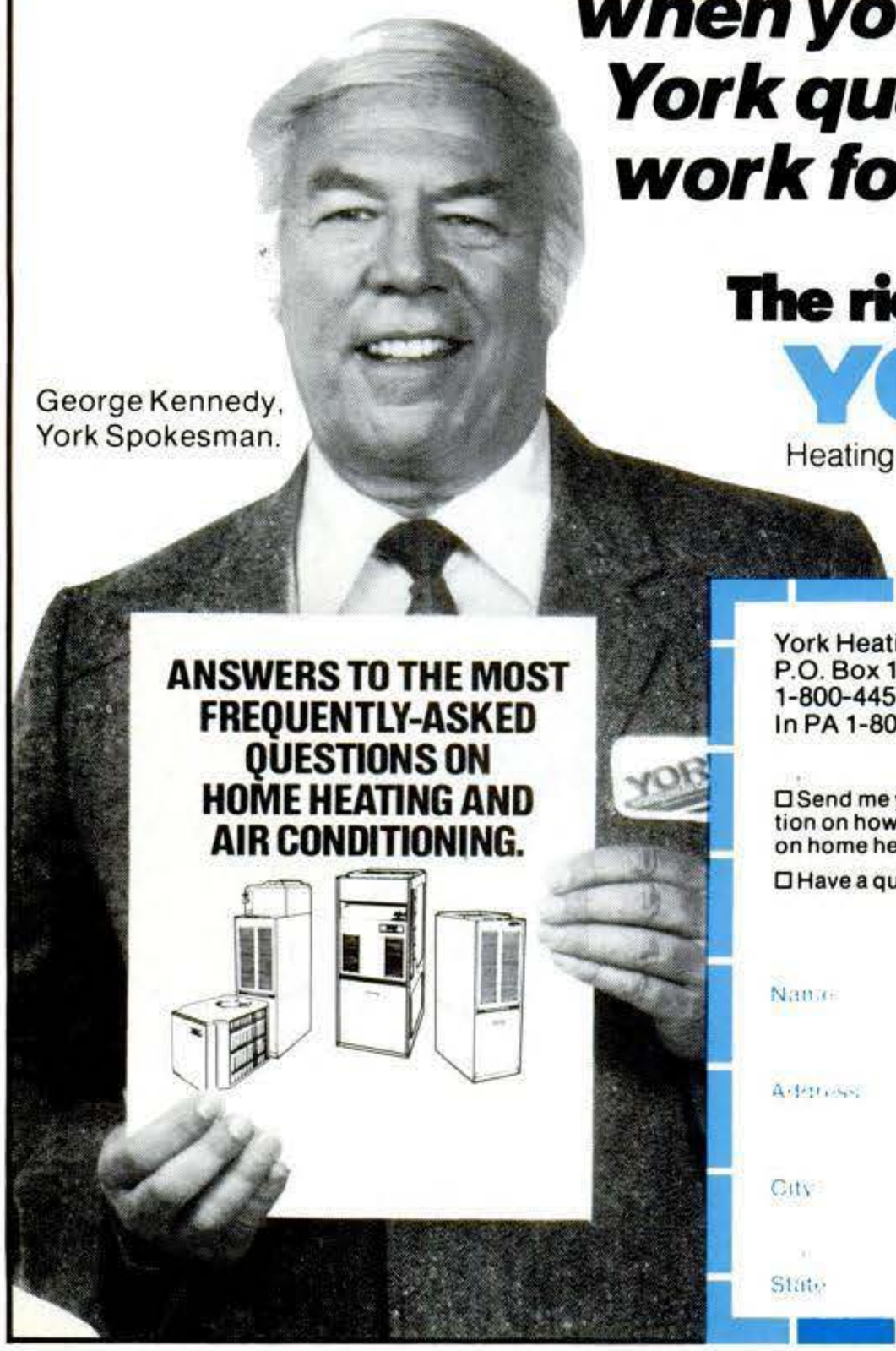

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Published monthly by
TIMES MIRROR MAGAZINES, INC.
380 Madison Avenue, New York N.Y. 10017
ISSN 0161-7370

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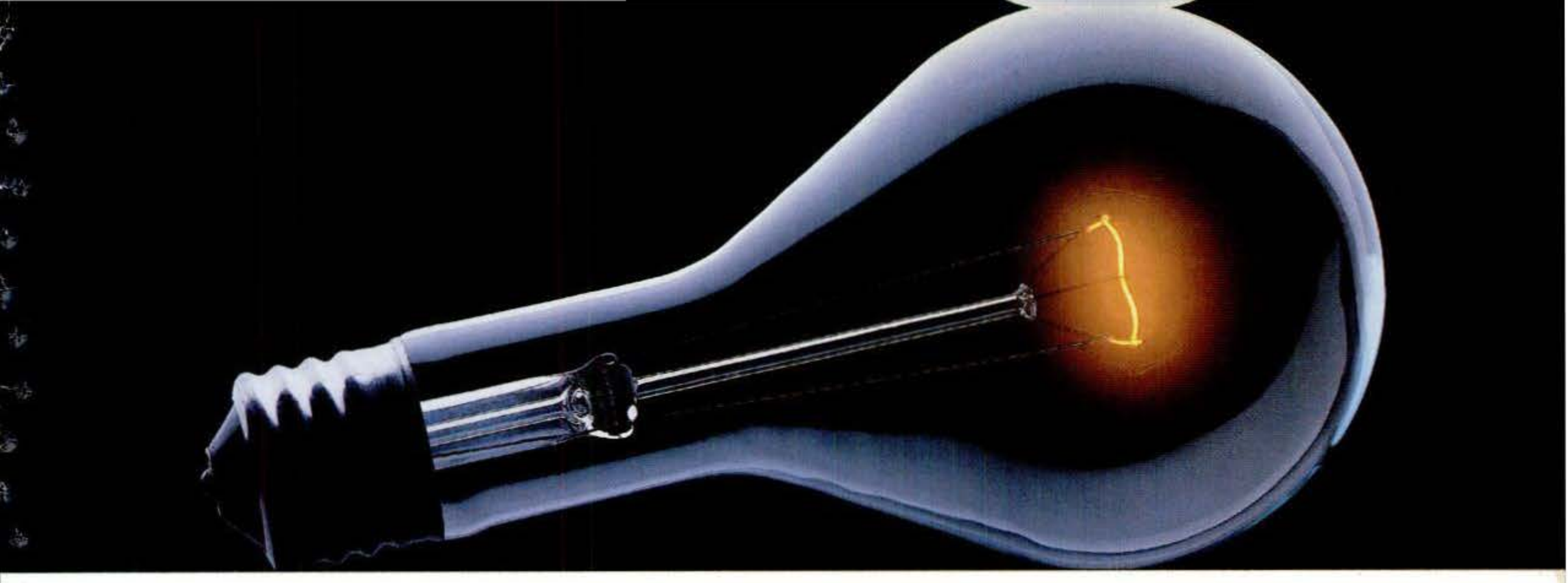

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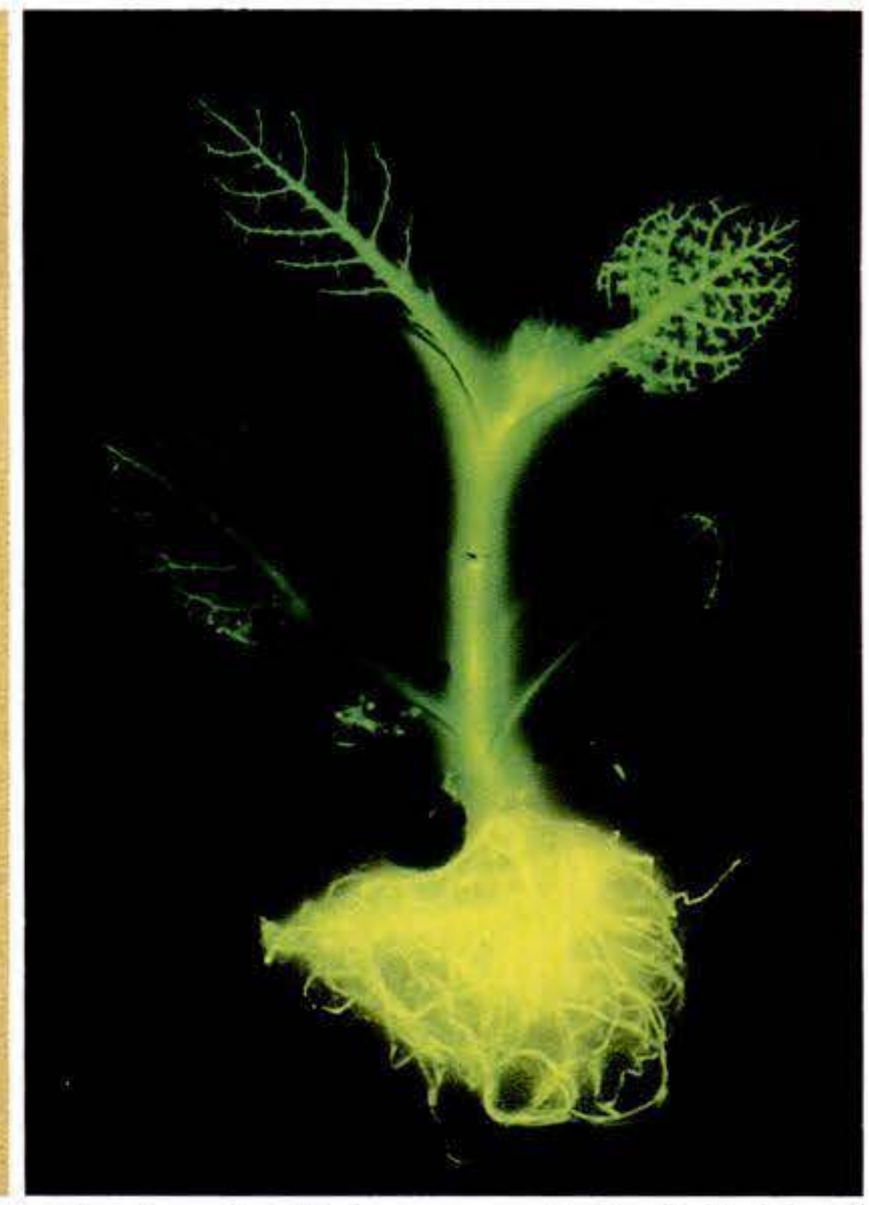
Science Newsfront

By ARTHUR FISHER

Glowing tobacco

The plant in the left-hand photo may seem normal, but it's not. It glows in the dark, as you can see in the right-hand photo. And it's not radioactive; it's bioluminescent. The plant is giving off the same light that lets fireflies brighten summer evenings. Why? Because scientists at the University of California, San Diego, have transferred into tobacco plants the gene that lights the firefly's fire.

"This is the first time anyone has taken a gene that codes for light production and transferred it into the genetic material of a complex multicellular organism," says Donald R. Helinski, a UCSD molecular geneticist who is one of the principal investigators on the experiment.



Scientists at UCSD have transferred the gene that makes firelies glow into this tobacco plant, so that it, too, glows in the dark (right). Purpose: to study gene expression.

The UCSD team used well-established recombinant DNA techniques to transfer the firefly gene for the enzyme luciferase into the DNA of the tobacco plant. The first step was to fuse the luciferase gene to a plant gene, and then insert the composite gene into a plasmid, a loop of bacterial DNA. The plasmid was transferred into bacteria that then injected the modified DNA, containing the luciferase gene, into plant tissues grown in the laboratory.

The experiment is significant because it offers researchers a way to trace gene expression—the way genes turn on and off—in living systems. When the plant gene is actively expressing itself, as when a new leaf is forming, the plant emits light that can be easily detected and measured. Tobacco plants were chosen because they are reasonably simple to work with and have been amply studied.

Swedish nuclear phase-out

Sweden's 12 nuclear reactors now provide roughly one-half of the nation's electrical power; hydroelectric plants provide the rest. Elimination of all nuclear power has been mandated by the year 2010, but the accident at Chernobyl prompted the government to ask a panel of experts to see whether that deadline could be moved up to 1997. Result of the study: Such a move is possible, but only if the decision is made immediately and only if the energy source is replaced by coal. The experts report that this move would hike the cost of electricity by a significant amount, and, furthermore, that coal is hardly attractive from an environmental standpoint.

Knockout for NO_x?

A common chemical used in swimming pools could be the key to eliminating the noxious pollutants called nitrogen oxides, or NO_x, from the exhausts of diesel engines and coal-burning power plants. In fact, says Dr. Robert A. Perry, a Sandia National Laboratories chemist, a new process he invented that uses the chemical "potentially could play a major role in controlling nitrogen oxide emissions from most combustion devices. Nitrogen oxides are major contributors to photochemical smog and are directly implicated in the occurrence of acid rain, particularly in the western United States."

The new process is called RAPRENOx, for rapid reduction of nitrogen oxides, and the chemical it uses is cyanuric acid, a harmless and relatively inexpensive compound widely used as a stabilizer for chlorine in swimming pools. When solid cyanuric acid is placed in the hot exhaust stream of a combustion cycle, it sublimes and changes into isocyanic acid, which mixes with the exhaust gases, reacts with the nitrogen oxides, and generates molecular nitrogen, carbon dioxide, carbon monoxide, and water. In a series of laboratory tests at the Combustion Research Facility in Livermore, Calif., which is operated by Sandia for the U.S. Department of Energy, the process removed more than 99 percent of nitrogen oxides present in the exhaust from a small diesel engine.

Perry and his collaborator, Dr. Dennis L. Siebers, emphasize that the process has been explored only under laboratory conditions, and that the technology for applying it—including engineering research, the development of chemical devices that could be fitted to commercial engines, and studies of performance under driving conditions—does not yet exist. The needed research and development

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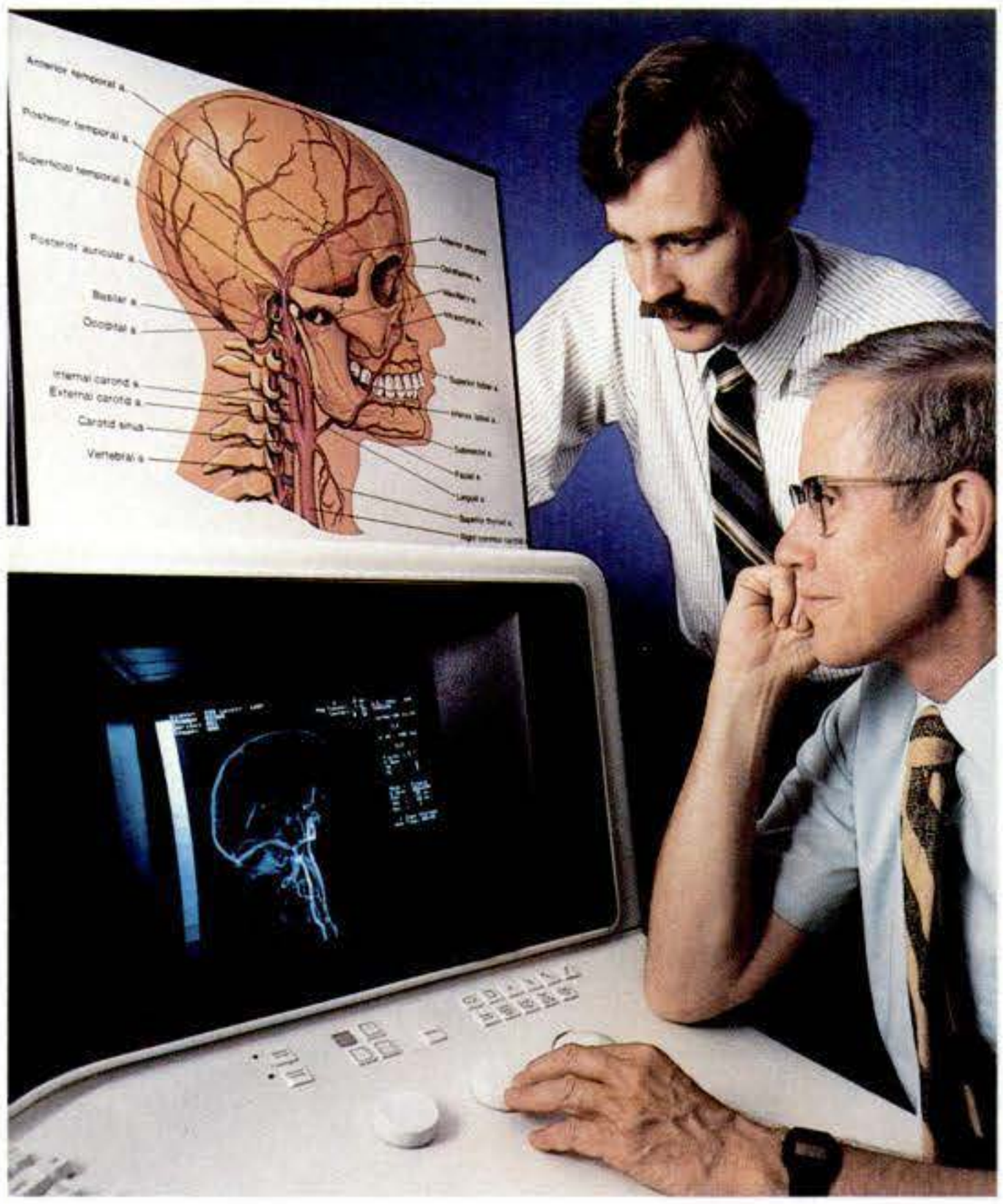
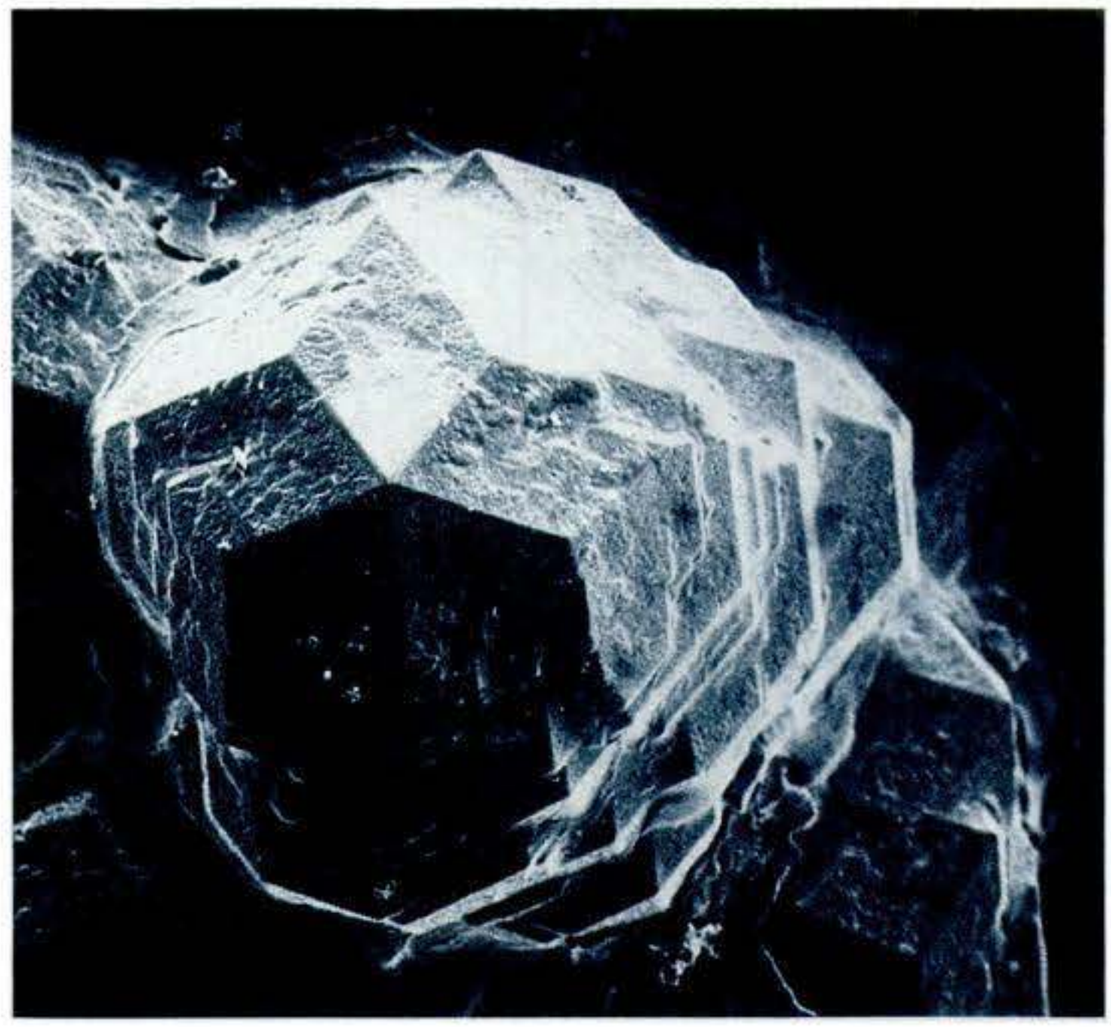


GE Scientists have developed this blood-flow checker (left), which uses the principle of magnetic resonance imaging. It's a non-invasive way to monitor blood flow in the head and neck. The quasi-crystal (below), a fine specimen of a new state of matter, was grown in France.



will now be carried out by the private industrial sector.

Blood-flow checker

Researchers at General Electric Co. have developed a new technique using magnetic resonance imaging to picture the flow of blood through the entire network of major arteries and veins in the head and neck. In the photo above, co-developers Drs. Charles L. Dumoulin (standing), a chemist, and Howard R. Hart, a physicist, watch as an image of the blood vessels appears on a computer screen. The faster blood flows through a vein or artery, the brighter its image.

The system, known as MR projection angiography, is the first noninvasive means of giving physicians a lengthwise view of the status of a patient's blood vessels. It should prove useful in the prevention and diagnosis of strokes and other cerebrovascular diseases, some of which are caused by constricted blood flow. The system has been tested in the laboratory, and will now undergo trials in a hospital setting.

Heavenly book

Marcia Bartusiak, a prize-winning science writer and PS contributor ["Mapping the Sea Floor from Space," PS, Feb. '84], has written a fine new book on the frontiers of astrophysics. Called *Thursday's Universe,* it is published by Times Books. Bartusiak charts the evolution of our knowledge of the universe, from the birth of stars out of dust and gases to the ultimate questions of origin and destiny. And through dozens of interviews with the astronomers and physicists at the cutting edge, she captures the flavor and excitement of their research. Highly recommended.

Salt talk

Scientists at the U.S. Department of Agriculture's Microbial Food Safety Research Laboratory in Philadelphia are beginning to unravel a mystery that has persisted for thousands of years: Why does salt preserve meat? Their studies show that the answer may be that salt short-circuits the electrical attraction between bacteria and food—meat spoilage is caused by bacteria.

When bacteria touch meat, they make very little surface contact—much like golf balls sitting on the floor, says Robert Benedict, a chemist at the center. "But as the bacteria grow, they spread out, hang on tighter, and are harder to get rid of. Salt appears to block this attachment." Apparently, the sodium and chlorine ions in a brine solution swamp the meat's surface with tiny electrical charges that interfere with the bacteria's ability to cling.

Salt may also kill bacteria by dehydrating them and interfering with their ability to extract nutrients from meat.

The USDA estimates that as much as 50 percent of the sodium in the American diet comes from processed foods, including poultry and meats. There is good reason to reduce this amount of sodium, which is a contributor to high blood pressure when ingested in excessive amounts. But if too little salt is used in meat processing, food poisoning from bacterial toxins can result. "We're learning more about how salt works and how using less of it affects control of bacteria," says Robert L. Buchanan, a USDA microbiologist working on the project. "Eventually, we'd like to find something to replace salt entirely."

Quasi-crystal

The beautiful gem in the photo above is the first sizable single quasi-crystal ever produced. It has 30 identical diamond-shaped sides, with five faces meeting at each vertex—the first direct visual evidence of five-fold symmetry in this newly discovered class of matter, neither amorphous nor conventionally crystalline ["SNF," April '85]. The aluminum-lithium-copper crystal, 0.5 mm in diameter, was grown at the Pechiney Research Center in Voreppe, France, with the French National Research Institute. PS

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Catherine Fahey, Junior
University of California, Santa Barbara

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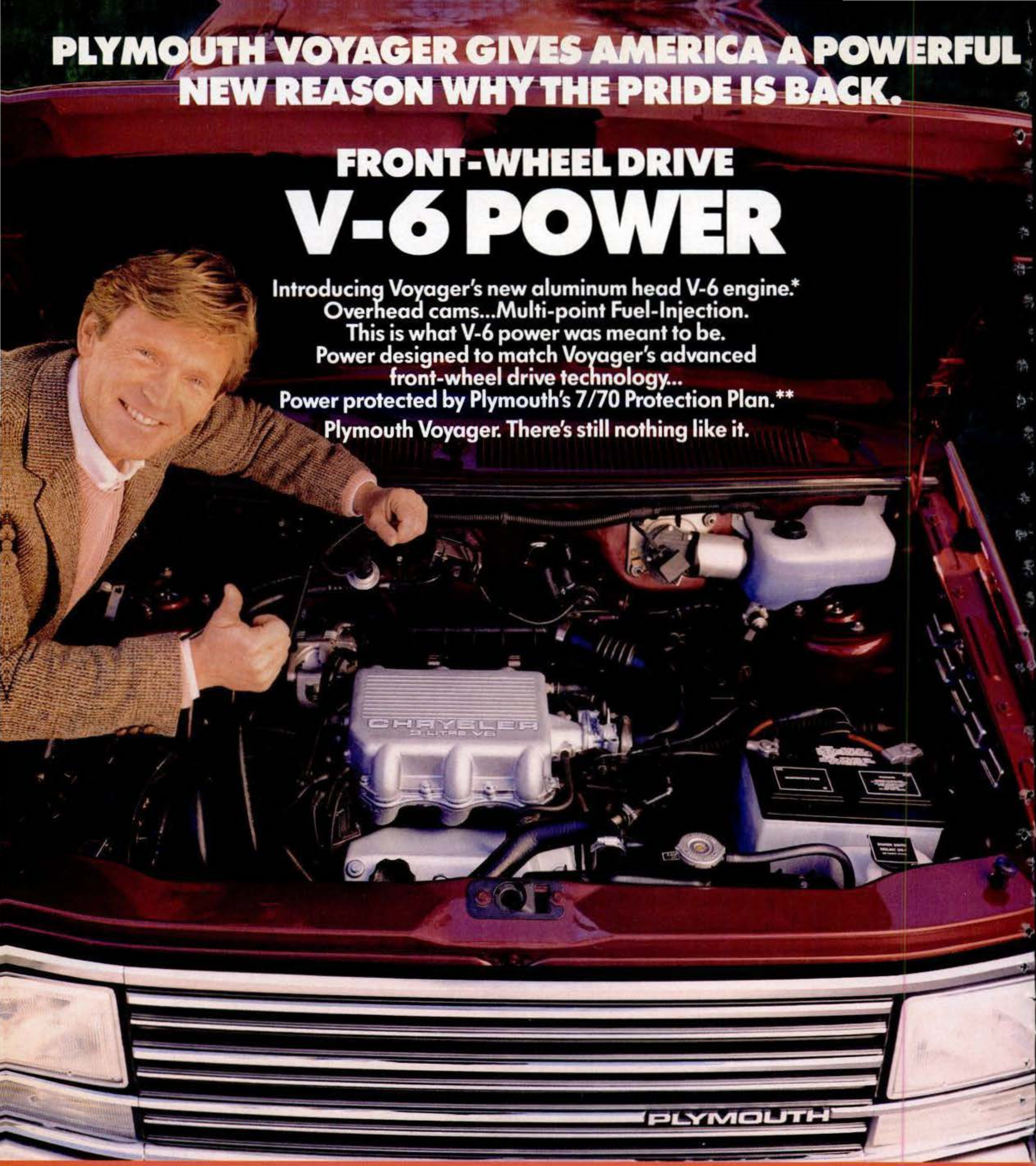

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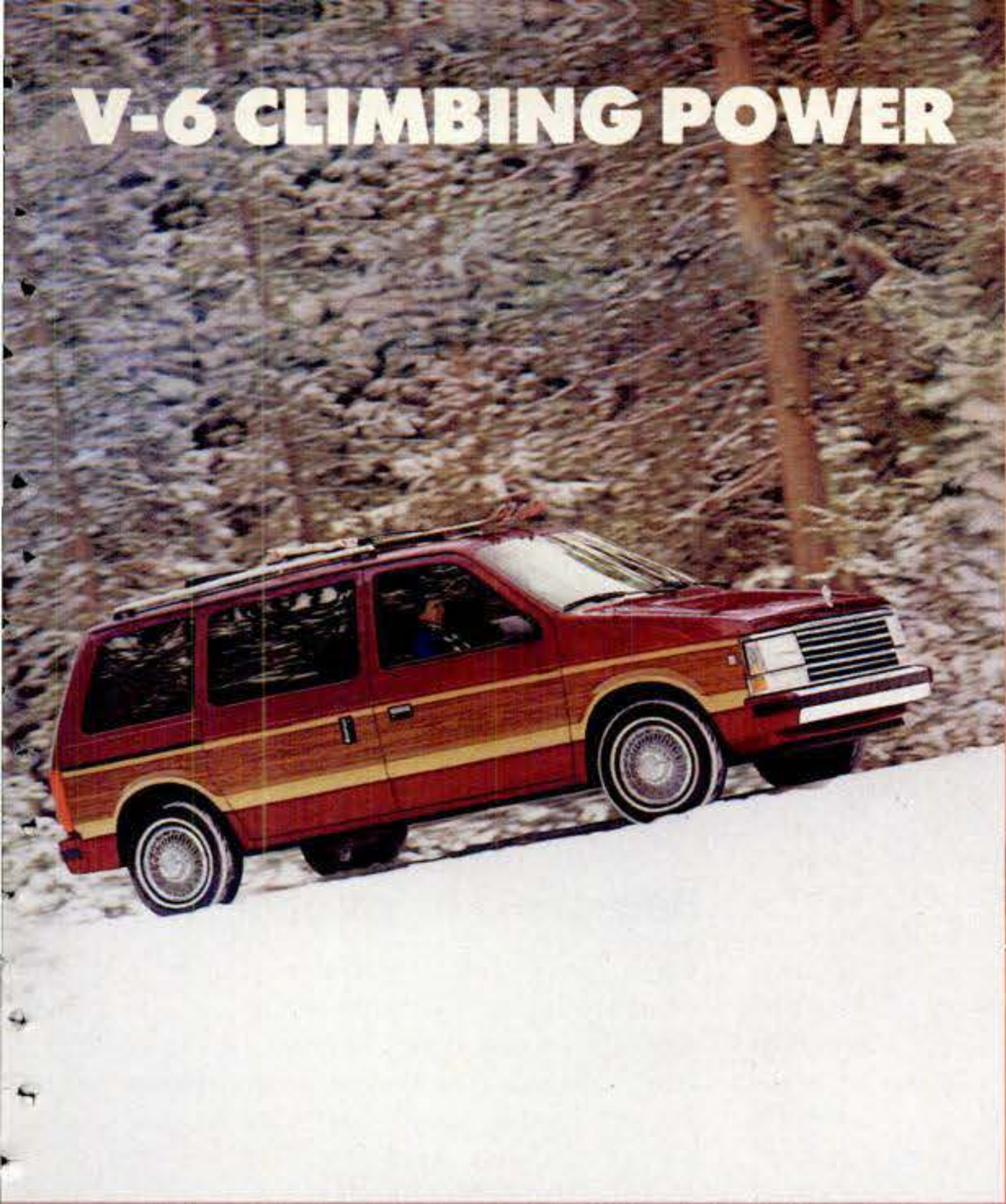

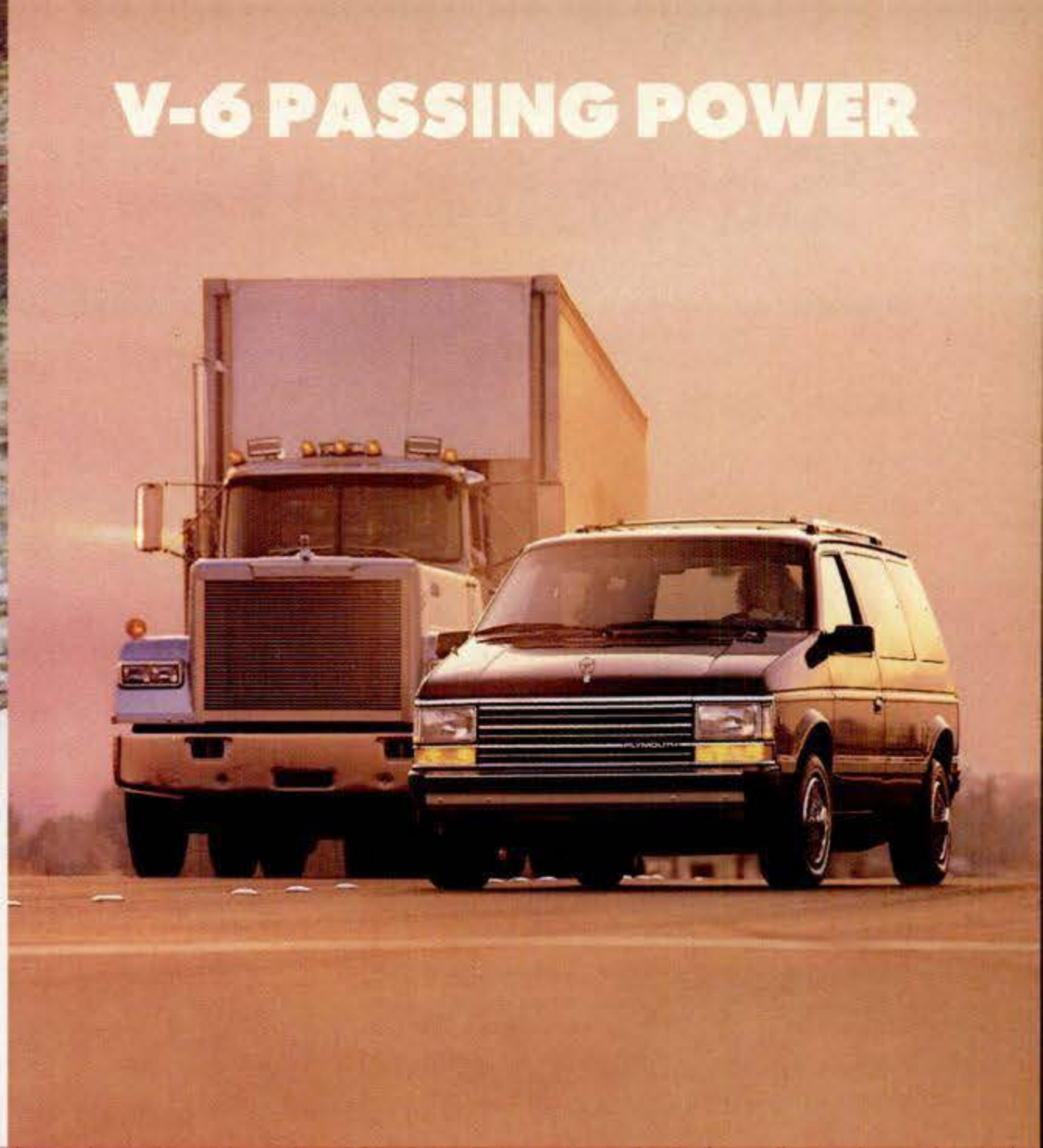

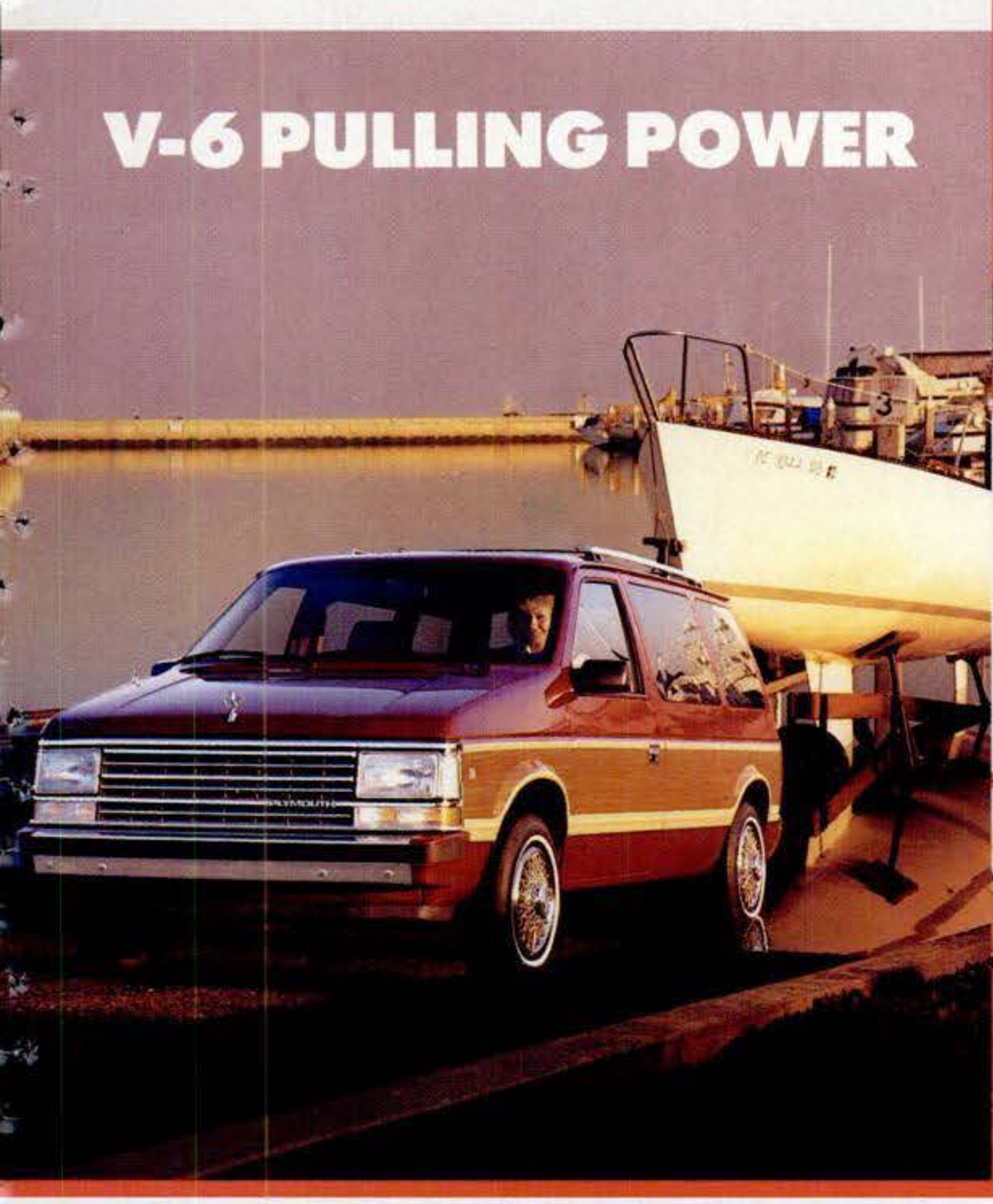

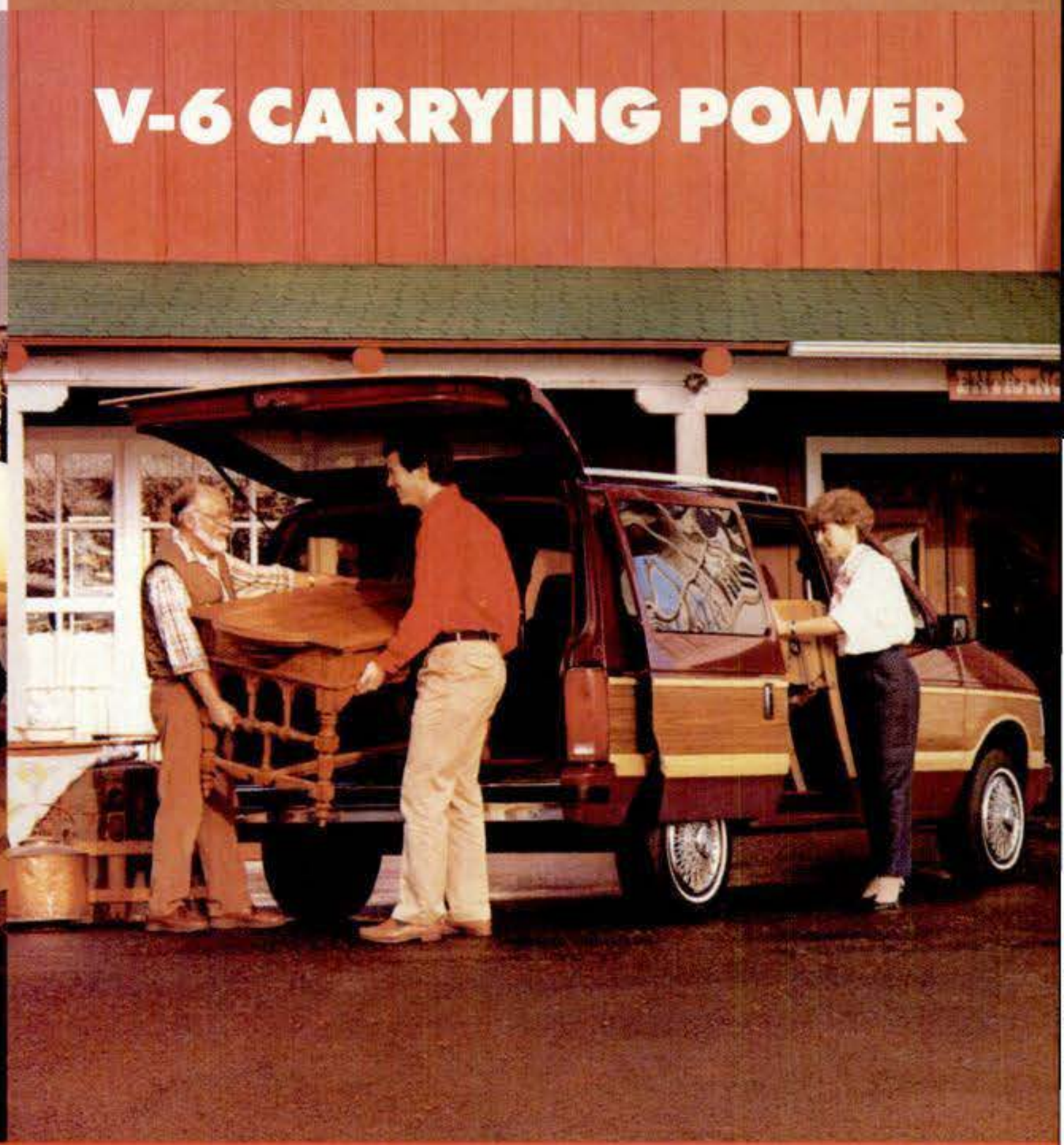

VOYAGER V-6

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Chrysler Motors: Best-built, best-backed American cars and trucks.†

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"Say, Smokey—"

A clinic on cars by Smokey Yunick, America's most famous mechanic

Diesel quits

My 1984 Chevrolet 6.2-liter diesel pickup starts instantly, whether hot or cold, then quits after 10 or 15 seconds as if it has run out of fuel. A considerable amount of cranking is required to get it restarted, which often drains the battery. Once started again, all is well. The dealer has checked the entire fuel system, injectors, filter, and glow plugs. I have installed an electric fuel pump, to no avail. Do you know what's wrong?

Frank S. Brunt
Keystone Heights, Fla.

Try just cracking the seal on the fuel filler cap when you park the truck. Then re-tighten it before you drive off. If the problem is cured, your fuel tank isn't vented correctly. Carefully check along the fuel lines and filter for any possible air leaks. If all fails, inspect the fuel pickup line in the fuel tank.

Simple water injector

For the past nine months I have been experimenting with a simple water-injection system I installed on my 1969 Renault 10. The system takes in water through a small jet connected to the vacuum-advance line, which is located above the carburetor's throttle plate. The jet (which I made from a 0.45-mm-diameter hypodermic needle) gives a water-fuel ratio of about 1:20. Cruising at 65 to 70 mph, I'm getting similar fuel mileage to what I used to get at 50 to 55 mph, and engine cooling has improved. This is without any added sensors, pumps, or computers. In a recent column, you cautioned against possible engine damage from water injection. Could there be any nasty delayed side effects from this modification?

Robert Mann, Auckland, New Zealand

Water injected into an engine will work its way into the oil supply. This can cause corrosion problems, particularly if the engine isn't always allowed to warm up beyond the boiling temperature of water. Water injection also causes oxidation of the cylinder heads, valve heads, valve seats, piston crowns, and upper piston-ring lands. Most of this damage occurs when the engine is shut down. In a stationary engine running around the clock, by contrast, corrosion would be much less of a problem. It is true that water injection can decrease an engine's tendency to detonate. But, over time, I think the negative results generally outweigh the positive ones.

Descending oil pressure

I have a 1979 Buick LeSabre V6 with an external oil-pressure gauge connected to the engine. After an oil and filter change the oil pressure is normal, but after about 1,500 miles the pressure is very low (5 to 20 pounds) and the oil is black. I use multi-viscosity Pennzoil 10W-30 oil; the engine uses about a quart every 500 miles. There are no oil leaks, and the engine doesn't appear to be burning oil. This problem started when the engine had 50,000 miles on it. At present the engine has 75,000 miles on it. What do you think is wrong?

Laurence E. Revell, Norfolk, Va.

It sounds as if the oil may be diluted with fuel. In any case, the pressure reads too low. Check it again using another pressure gauge. If you find the oil isn't fuel-diluted, there's either a problem with the oil pump, worn bearings, or loose lifter bores. This sounds like an engine that may be very dirty inside. To find out, pull off the valve covers. If there's a mess of sludge inside, a clogged positive-crankcase-ventilation (PCV) system may be the cause. There's no cure for a dirty, worn engine short of an overhaul.

Oil gluttons, oil misers

I recently purchased a 1986 Ford Mustang GT with the 302 V8 engine. It has used a quart of oil in 800 to 1,000 miles. The dealer and the Ford district manager say it's normal for a new car to use a quart of oil every 500 to 700 miles. I would like to know why this condition exists, and whether it will shorten engine life.

Richard Dedrick, Cliffside Park, N.J.

Most new engines will use some oil until the piston rings have seated against the cylinder walls. After an engine has about 5,000 miles on it, the rings will have seated as well as they are going to, and oil consumption will stabilize. At that point, I've seen oil consumption in identical engines range all the way from 600 miles to 6,000 miles per quart. The reason is that manufacturing tolerances in some engines will coincide on the looser end of the acceptable range, making those engines worse-than-average oil burners. Engines built with parts that happen to be on the tight end of the tolerance range will be oil misers. I personally feel that an engine should be able to go at least 3,000 miles before needing a quart of oil.

Detergents in gasoline

I am concerned about the article in POPULAR SCIENCE concerning the importance of detergent in gasoline ["Bad Gas," March '86]. Would it be cheaper for me to use an additive in my gas tank or to pay a premium price for Mobil detergent gasoline?

Harry Borowy, Erie, Pa.

Don't play chemist. Invariably, you'll pay too much for what you eventually learn. I advise using the new detergent gasolines that are currently being advertised; they can really help clean up the fuel-system troubles caused by the poor gas we've gotten in recent years. Detergent is particularly important to multi-point fuel-injection systems; carburetors will work satisfactorily with good-quality non-detergent fuel.

Stiff steering

When my 1979 Mercury Zephyr is first started cold, it takes muscle to make the first two or three turns of the steering wheel. Thereafter, the power steering is normal until the next cold start. This symptom becomes more pronounced as the weather turns colder.

John Nymoen, Robbinsdale, Minn.

In the engineering business, I believe, this category of problem is referred to as "morning sickness." I'd say the seals in the power-steering unit get tight when they're cold. This could be fairly expensive to fix, so I would try to live with it. It's possible you missed a Ford recall on this problem. Ask the company—there's an outside chance you could get some help.

Got a car problem? Send it to "Say, Smokey—," POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. All letters are read, and those of widest interest are answered in this column. Due to the large volume of mail, Smokey cannot reply to letters not selected for publication.

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Porsche 924S

PHOTO BY THE AUTHOR

Porsche 924S features a 147-hp 2.5-liter four-cylinder engine, which it shares with Porsche's more expensive 944.

HOW A SERIOUS DRIVER

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By JACK KEEBLER

The 924S has been called the poor man's Porsche. But is it really good enough to wear the badge? I spent a month and 3,000 miles at the wheel of this $23,500 coupe to determine whether it offers the engine performance, high-speed handling, long-distance interior comfort, and powerful braking befitting a member of this prestigious line of sports cars.

Eleven years ago Porsche introduced the 924 to America. When PS last tested it [Nov. '78], the 924 meandered from 0 to 60 mph in 12.2 seconds. Powered by a two-liter four that made only 110 horsepower, it couldn't keep up with less expensive cars like the Mazda RX-7 and Nissan Z-car. Worse, its Audi-derived engine led Porsche fanatics to view the 924 as a pretender, and Porsche eventually withdrew the car from the U.S. market.

Last year, the hatchback was reintroduced to U.S. buyers, powered by a larger 2.5-liter Porsche four with tuned intake and exhaust manifolds. This all-aluminum engine pumps out a healthy 147 horsepower at 5,800 rpm. So I wasn't surprised when my five-speed-equipped 924S scooted to 60 mph in just 9.6 seconds. What was a surprise was the un-Porsche-like fuel economy. During the month I drove the car, it averaged 22.5 mpg during commuting between home and New York City. The worst mileage recorded was 18.2 mpg; the best was 27.5 mpg on a long highway trip.

Like the fuel economy, the car's smooth ride was a pleasant surprise. The suspension, based on that from the 944, lets the body roll only slightly during high-speed cornering. And bumps don't pound you. In fact, the ride of the 924S feels a good deal like that of a large European luxury sedan. This smooth ride is further enhanced by the car's simple, yet impressively supportive, front bucket seats. The rear seats are for tiny children only, and luggage space is modest.

The 924S steering system is impressive. The power-assisted rack-and-pinion unit is both accurate and communicative. Pick a spot several hundred yards ahead, and the 924S tracks to it like a slot car. And rarely have I held a steering wheel that provided so much feedback about where the wheels were pointed and how much grip they had. One minor inconvenience was the nonadjustable steering column, which was angled too low for short pilots.

Like all Porsches and most sports cars, the 924S is rear-drive. But unlike most rear-drive cars, the front-engine 924's five-speed transmission is mounted in the rear for more even weight distribution. Because of the distance from the shift lever to the transaxle, I expected some gear-shift notchiness. Instead, shift effort proved to be extremely low, and I found myself using just my finger tips to gently nudge the shifter back and forth through the well-spaced ratios. What wasn't low-effort was the clutch pedal. In heavy traffic and around town its heavy spring tired my leg quickly. (An automatic is also available.)

Slowing the 924S are four 11-inch vented disc brakes, which provided quiet, smooth speed control. But this quiet and smoothness don't come at the expense of muscle. The brakes scrubbed speed so quickly during one highway emergency that the shoulder belt left a small bruise on my collarbone.

The 924S is quick and provides the comfort for long-distance cruising. It handles precisely and stops well. It's a Porsche. PS

VIEWS THE WORLD.

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Coming next month in Popular Science

The Great 1987 Outdoors

A special section covering what's happening today in the areas of boating, fishing and camping.

Watch for it!

FMX boosts stereo fidelity

Emil Torick is standing by the first mass-produced FMX radio tuner, a $500 NAD 4300 made by NAD Electronics. He asks me to imagine myself in a hi-fi showroom. "The salesman says, 'Now, look. Here's a weak signal.' " Torick presses the tuner's FMX switch off, unleashing a torrent of static that all but drowns the chords of a guitar arrangement of Scarlatti's D Minor Toccata. "And the customer replies, 'Oh, yeah. That's just how station XYZ sounds in my house.' "

Then Torick flips the FMX switch on again. The hiss suddenly diminishes, and Scarlatti swells. You can achieve a similar effect on your own radio by switching a distant FM station from stereophonic to monophonic reception. But FMX preserves stereo sound far beyond the range of a conventional stereo broadcast.

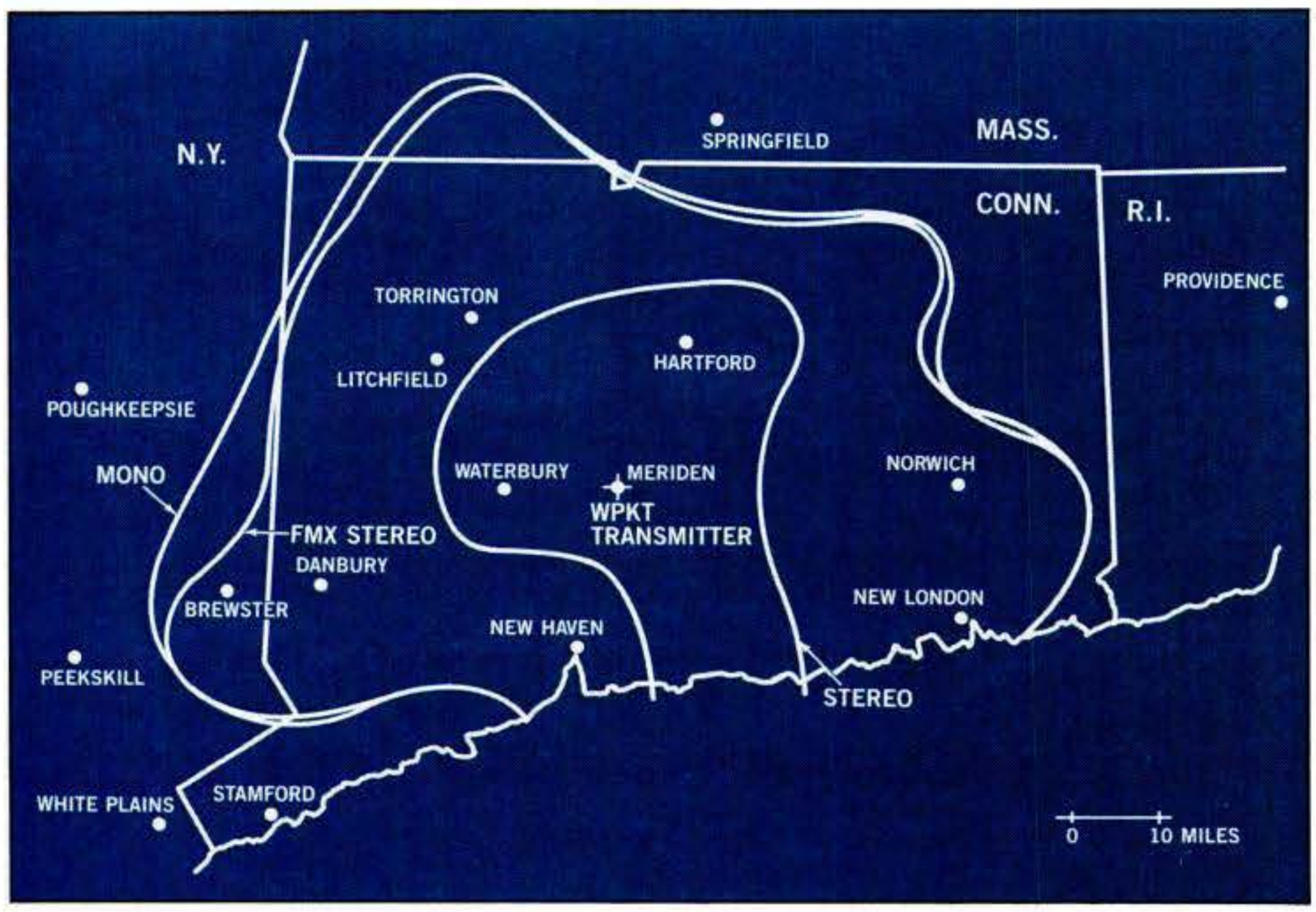
We aren't in a hi-fi store, but in a studio at the CBS Technology Center in Stamford, Conn., where Emil Torick, co-inventor of FMX, is vice president for audio technology. The X in CBS's FMX trademark, he explains, "is for expanded—both in the technical sense as a noise-reduction system and because it gives an expanded area of coverage."

Normally, the stereo part of a radio signal doesn't travel as far as other components. That's why you can receive a clear mono signal in an area where the stereo signal is spoiled by hissing. In FMX broadcasting, special electronic hardware picks out the low-level stereo signals that might be swamped by noise and boosts them safely above the noise level. At the receiver, a decoder brings them back down to the right sound level—and lowers the noise level an equivalent amount, making it almost inaudible.

"FMX just takes away the noise," marvels Bob Tarsio, chief engineer for WLTW Lite FM in New York, N.Y., one of several stations around the country conducting trials. "It buys back your mono coverage in stereo." Tarsio expects to add "at least four or five extra counties" to WLTW's coverage area if his station opts for FMX. In New York, that means perhaps a million potential new listeners. Of course, FM stations will continue to broadcast conventional signals for listeners who don't buy FMX receivers.

CBS has released technical data to more than 30 radio manufacturers, and semiconductor companies Sprague Electronics and Sanyo are working on integrated FMX decoder chips. According to Torick, the chips should be available in quantity later this year, priced to add less than $5 to the retail cost of a radio.

As of this writing, CBS and the National Assn. of Broadcasters—co-owners of the FMX technology—are in the final stages of forming a new company to develop and license the service.—*Hugh Aldersey-Williams*



For a received signal-to-noise ratio of 60 dB, public radio station WPKT's FMX service effectively quadruples the area of stereo coverage. Except for a mountainous area in the western sector, FMX extends as far as mono.

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The 1750 Capri Bowrider, one of five totally new designs for 1987, offers the rare twin luxuries of roomy interior with first-class accommodations *and* compact, low-profile design for super ski performance and easy trailering.

To the 1950 Capri Bowrider—America's best-selling runabout ever—we've *added* to an already enviable collection of standard equipment and styling innovations.

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2150 Capri Cuddy
only
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1750 Capri Bowrider
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Automotive Newsfront

By DAN McCOSH Detroit Editor

Chrysler's Concept Voyager show car promises relief from the boredom of long-distance driving.

Concept Voyager

A bored six-year-old driving his parents crazy on the Pennsylvania Turnpike must have been the inspiration for Chrysler's Concept Voyager, a high-tech solution to the problem of long-distance cruising.

Unveiled recently at the Detroit Auto Show, Concept Voyager embodies a number of family-oriented features likely to emerge soon on production models, said Joseph Caddell, Plymouth general marketing manager.

Starting with Plymouth's new Gran Voyager stretched mini-van, Chrysler designers raised the roof to create an overhead compartment containing slide-down storage racks and water tanks. An extended windshield and rounded front end enhance the aerodynamics of the vehicle.

The swoopy, molded-plastic interior sports convenience features ranging from a propane stove, sink, and refrigerator behind the rear seat to a portable vacuum cleaner in a recess in the side panel. A rear-projection instrument panel incorporates a global-positioning navigation system being developed by Chrysler's electronics division. A pop-up video screen in the rear includes games for the kids.

Dual-section tires developed by Goodyear—capable of running flat if one section is deflated—are among the features likely to appear soon on production models, Caddell said. Also on the way is molded-foam fabric-covered seating using a new system of manufacturing that allows deep contours and added back support.

Whither 4WD?

With the Pontiac STE and Fiero and Chevrolet Beretta and Cavalier all candidates for four-wheel drive—some as soon as the next model year—insiders say General Motors engineers still are unhappy with most existing full-time four-wheel-drive systems.

The recent collapse of the GM80 program, a proposed replacement for the current rear-drive Camaro, was partly due to the inability of engineers to put some 200 horsepower through the front axle without encountering unacceptable torque steer. (Torque steer is what engineers call the wandering and instability that plagues a high-output front-drive car as the driving forces tug at the steering and suspension.)

Development of future high-performance models at GM thus involves full-time four-wheel-drive systems. One big problem so far is that the differentials that keep the front and rear paws in sync are either too expensive or don't work.

Even the viscous drive used to couple the front and rear axles of several European production cars is failing early durability tests with high-horsepower engines. Among the alternatives being tested by GM are center differentials that use multi-plate clutches, and traction-control computers that use signals from the anti-lock brake sensors to control an electronic throttle. So far, however, neither works reliably enough to satisfy GM engineers. The next generation of high-performance cars awaits the answer.

Muffling noise

Grumbling about engine noise is near an end, say Chrysler insiders about their 2.2-liter four-cylinder. The re-engineered engine, due sometime in the next year or so, has been designed around a sound-encapsulation package intended to quiet the durable but often harsh-running engine.

But muffling four-cylinder roughness isn't the only answer. Chrysler, which recently introduced a Japanese-built V6 in its mini-van, will likely begin production of its own V6 in the three-liter range in 1989, say insiders. The new V6 would be 60 degrees between cylinder banks, unlike Chrysler's current 90-degree V6 truck engine. The 60-degree bank is inherently smoother than a 90-degree design, due to its even firing intervals. The narrower block is also easier to mount sideways in a front-drive car.

After the flood

The deluge of new models being brought into the U.S. market by both domestic and foreign manufacturers will be quickly followed by a series of refinements, upgrades, and broader product ranges.

- Subaru, which only recently un-

Continued

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Motorcraft spark plugs.

THE LIGHTNING BEHIND ITS THUNDER.

It stormed onto the American performance scene. The Thunderbird Turbo Coupe, moved by a sophisticated four-cylinder turbocharged engine that's as powerful as a V-8. And the lightning behind its high-revving thunder: Motorcraft extended-tip spark plugs. Their nickel-chromium-alloy electrodes are designed to cope with the intense heat of today's high-performance engines. There's a Motorcraft spark plug, as well as a full line of quality-made Motorcraft parts, available for all makes of cars and trucks.

Motorcraft from Ford

EXCEEDS THE NEED

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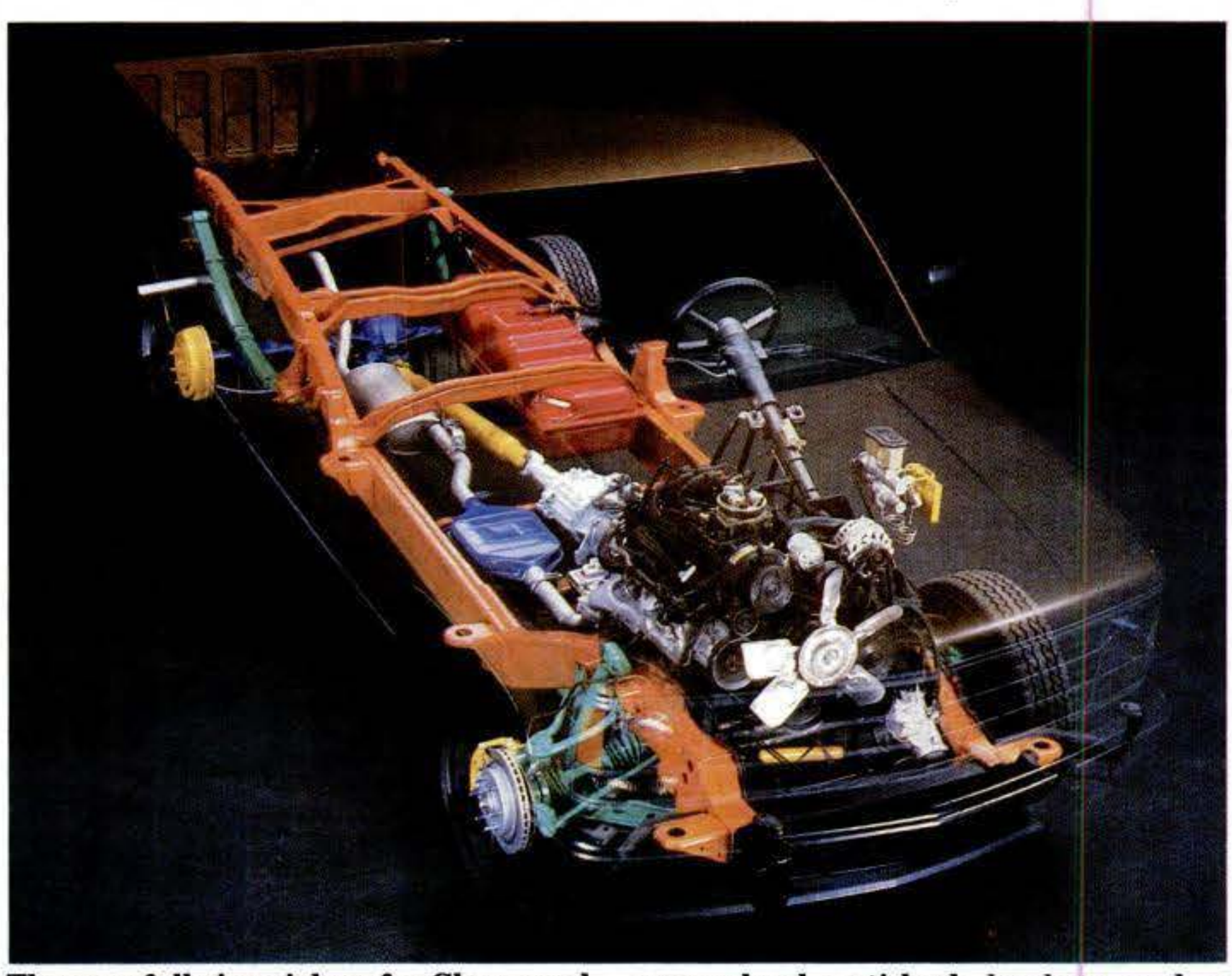
veiled its new 1,200-cc Justy front-wheel-drive mini-car, says the Justy will be followed up next year with a four-wheel-drive version that's already on sale in Europe.

- Austin Rover Cars of North America, which just introduced its new Sterling luxury sedan—based on the Honda's Acura Legend, but made in England—says its next car in the U.S. will be a four-door hatchback. This practical Sterling will then be followed by an all-new, highly stylized two-door sport coupe to be based on the Rover 800 Coupe that stole the spotlight at last spring's Turin Auto Show.
- A specially built two-liter 16-valve engine recently shown in a Pontiac Le-Mans "idea car" will appear in a 1989 Opel, and is being considered for U.S.-built cars as well, GM says.
- A Pontiac engineer reveals that the Manhattan Project engine, which features a one-piece cylinder head and block, has survived the recent program cuts at GM. It's said that actually manufacturing the engine will call for more development of the "lost foam" casting process [PS, April '86], which uses plastic-foam cores set in a sand mold to cast complex shapes.



The new full-size pickup for Chevy and GMC will feature molded foam seats, rear-wheel anti-lock brakes, and a carbon-coated aluminum drive shaft.

Pickup progress

A promising new way of manufacturing vehicle seats that has been under development at GM for some five years finally hits the market in the company's all-new full-size pickup truck.

GM tried and rejected several seat-making methods before settling on a system in which the entire seat is molded from a single block of foam with a bonded cloth surface. The labor-saving technique results in a deeply contoured luxurious seat that looks almost out of place in a pickup truck. In fact, the seat was intended to debut on the recently introduced Chevrolet Beretta as part of a luxury-interior package. "But they wanted the truck guys to take the chances," says a truck engineer.

Chevy and GMC's new full-size pickups are being billed as the first all-new light trucks in some 15 years. Rear-wheel-only anti-lock brakes are featured, along with a new chassis, body, and interior.

Modular trucks

Ford has been studying a comprehensive redesign of its light-truck fleet, based on a modular concept that will allow all its light trucks to be assembled from a handful of basic components.

Dubbed the Beta program, Ford had previously hinted that it was a study to reduce manufacturing costs, similar to General Motors' Saturn project.

But Beta now is expected to be the basis of future Ford trucks starting in 1993. Current plans call for a basic chassis that can be built in three wheelbases, from 93 to 126 inches.

Ford plans to spawn as many as 13 light trucks and utility vehicles from Beta. Front-drive vans, rear-drive pickups, and four-wheel-drive utility vehicles are included in the program. Variants include a nine-passenger front-drive van, a two-door mini-van, and a five-passenger pickup with four-wheel drive. It's a mystery why Ford would try to build such a wide variety of wheelbases and large number of models on a universal platform. Insiders say that Ford is determined to simplify truck manufacturing so that final assembly can be automatic.

The Ford Beta project comes two years later than Chrysler's planned revamping of its conventional pickup and van lines, expected as soon as 1991. GM plans to replace its full-size vans in 1990, while a new front-drive GM mini-van is expected by 1989.

A peek at Premier

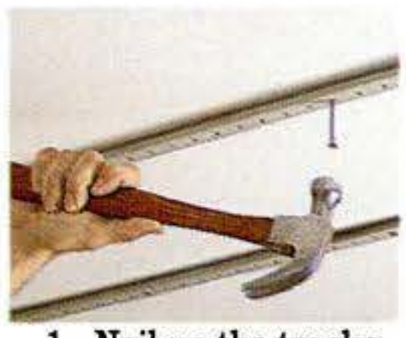
The next North American-built car planned by American Motors Corp. is the Renault Premier, to be introduced as an '88 model this fall. Power is expected to be provided by a 2.8-liter V6 currently used by Peugeot and Volvo. The Premier will be built in AMC's Bramalea, Ont., plant. PS

Contributors: David Scott (Europe), Tom Wilkinson (New York)

PHOTO BY HIDDEN IMAGE

Renault plans to build 90,000 of its new mid-size car, the Premier, in Bramalea, Ont., starting in the fall of 1987.

Want to keep the noise down?



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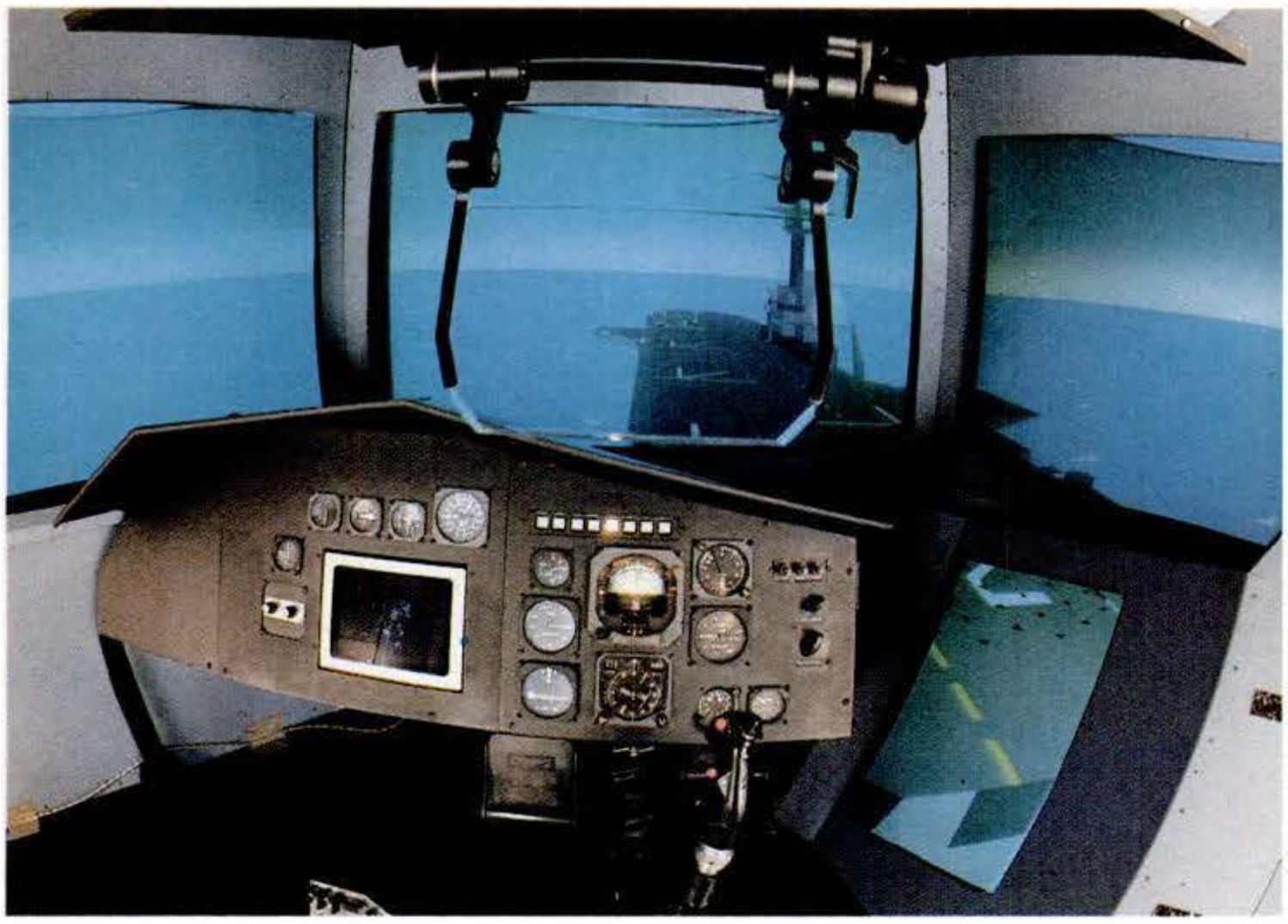
Electronics Newsfront

By WILLIAM J. HAWKINS



NASA research simulator uses computer-controlled screens to surround the pilot with a re-creation of flight as seen aboard a yet-to-be-designed craft.

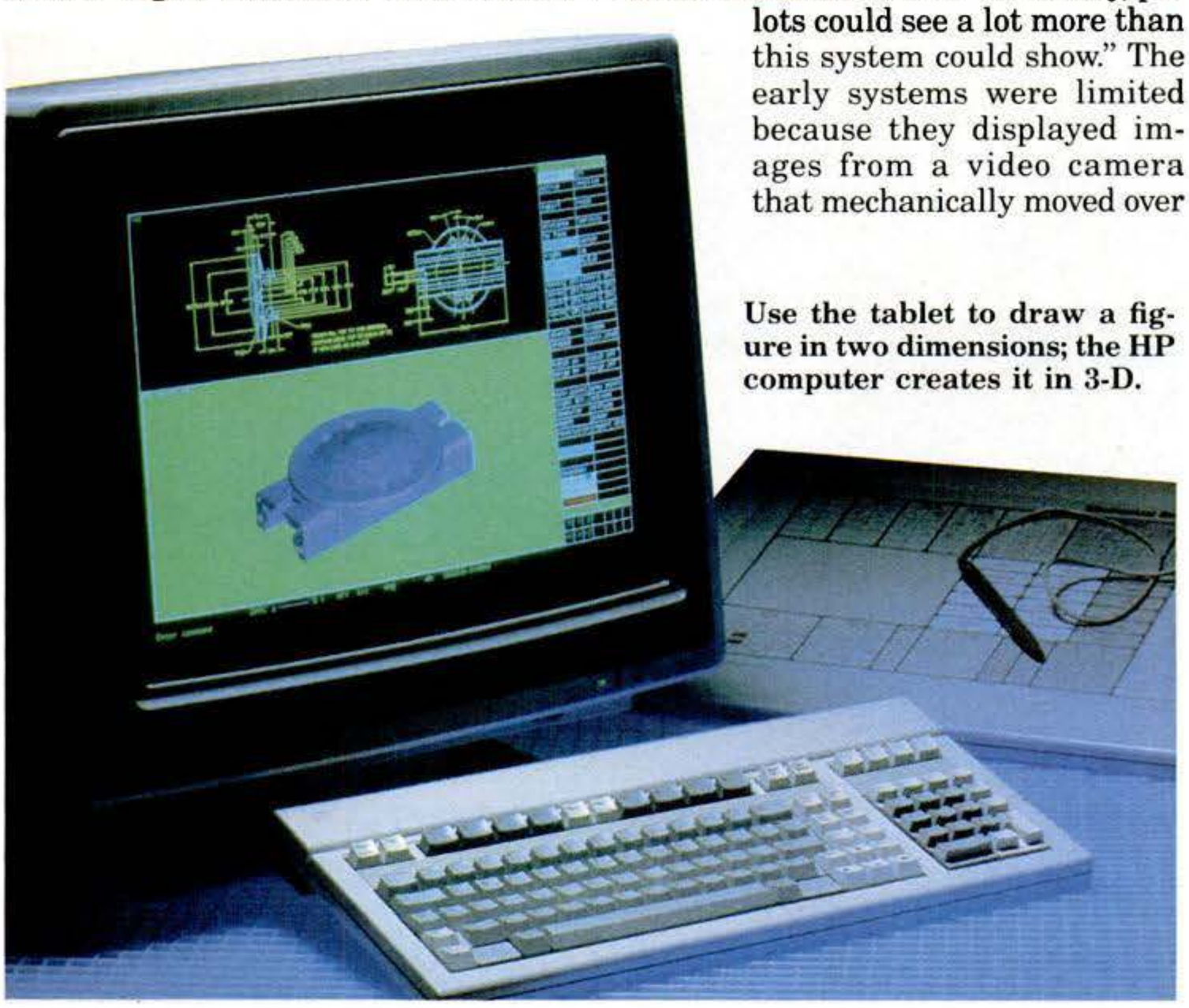
Flying into the future

NASA has a problem: How can its pilots fly an aircraft that does not yet exist? On-the-job training is not available, and word-of-mouth just won't do. So, like other aircraft makers, NASA uses a flight simulator. But NASA's research simulator now uses a computer to create realistic left-, center-, and right-window images.

"Pilots using earlier simulator systems saw a single windshield-only view," says Tony Cook, manager of operations at NASA's Ames Research Center simulation labs. "In reality, pilots could see a lot more than this system could show." The early systems were limited because they displayed images from a video camera that mechanically moved over a mock landscape built in a studio.

"With the new system," continues Cook, "the scene can be changed by changing computer software." Because the computer creates all three images, the system is more realistic. "Though a pilot may be focused on an object straight ahead," says Cook, "he depends on images in his peripheral vision for assessing attitude, altitude, and speed when landing."

In less than four hours, the simulator's cab can be changed and the computer re-programmed for research on another craft—from a new shuttle to a future helicopter.



Use the tablet to draw a figure in two dimensions; the HP computer creates it in 3-D.

Shape maker

You've just designed the world's first widget by creating a two-dimensional drawing of it on Hewlett-Packard's new ME Series 30 CAD (computer-aided design) system. To see what your idea *really* looks like, give commands such as "MILL," "BORE," "STAMP," or "EXTRUDE": The clever computer produces a three-dimensional image of a "machined" component. With other commands, such as "COPY," "MOVE," "ROTATE," "MIRROR," and "SCALE," you modify the drawing; an "UNDO" command returns the screen to your original concept.

Super VHS

JVC, originator of the VHS VCR format, has developed super-VHS, called S-VHS. Currently, not much is known about the system except that an S-VHS VCR uses a new oxide particle tape (not metal) for better than 400 lines of resolution. (Standard VHS is about 230.) That makes S-VHS better than conventional broadcast TV (about 330 lines), capable of keeping up with the quality of videodisc players and high-definition TV. An S-VHS machine can record or play tapes in the old or new format, but S-VHS tapes can't be used on a VHS machine. Rumors are that machines could be available by this summer for about $200 more than standard VHS models.

Consumer electronics update

"It looks like an ordinary computer game, doesn't it?" Gary Yost of Antic Software asked me as I walked by the Atari booth at the Las Vegas Con-

Continued

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The Yamaha Terrapro.™ Think of it as a Veg-O-Matic for the yard.

It mows. It tows. It sprays. Introducing the Yamaha Terrapro.™ The first all-terrain four-wheeler designed to work around the yard. Or down on the farm.

The secret behind the Yamaha Terrapro is the PTO that lets you work mowers and sprayers.

Because it's the only four-wheeler that has a rear-mounted ASAE standard 1-inch 2,000 rpm, 10 horsepower PTO (Power Take Off).

Translated, that means the Terrapro has a PTO power hookup in back that can operate a variety of mowers and sprayers.

For example, our Yamaha mowers made exclusively by Woods. The 48-inch finish mower makes having neatly trimmed lawns as easy as sitting down. While the Yamaha 42-inch rough-cut mower eats up grass, weeds and light brush.

For spraying fertilizers, herbicides, or insecticides,* there's our Yamaha system of sprayers manufactured by Broyhill. They come in 50 and 100 gallon sizes with a convenient hand-held sprayer. And you can get an efficient 15-or 24-foot boom. Both boom systems have a modular design that can be arranged into various configurations, so you won't be.

Like you, when the Yamaha Terrapro isn't working, it's playing.

A Yamaha mower trims hours off your workday.

Of course, the Yamaha Terrapro isn't all work and no play. With a hefty 349cc, 4-stroke engine and high-flotation tires, you can even ride out in the mud. And come back.

So call 1-800-331-6060 ext. 675 now about the new Yamaha Terrapro.™ Our dealers are standing by.

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The Yamaha sprayers will help eliminate insects, fungi, weeds and long days.

**Warning: Use of certain chemicals may cause injury and property damage. Read sprayer owner's manual and follow chemical label directions.*

180 day limited warranty includes Terrapro and Yamaha sprayers and mowers. Warranty terms are limited. See your Yamaha dealer for details. Dress properly for your ride with a helmet, eye protection, long sleeved shirt, long trousers, gloves and boots. Specifications subject to change without notice. Designed for off-road, operator use only. This product is to be used by one person only. Yamaha and the Specialty Vehicle Institute of America encourage you to ride safely and respect fellow riders and the environment. For further information regarding the SVIA rider course, please call 1-800-447-4700. Do not drink and drive. It is illegal and dangerous.

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LIVE THE ADVENTURE

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sumer Electronics Show. He held out a pair of glasses. "Try playing with these on," he said. A computer... a game... a curious pair of glasses. I was hooked. I put on the glasses, and the screen on the Atari 520 ST computer took on another dimension—literally. I was trying three-dimensional glasses from Antic (524 Second St., San Francisco, Calif. 94107). The liquid-crystal lenses act like shutters to create a 3-D image when used with the company's software. Although a 3-D game could challenge my mind, another add-on—for Commodore's 64 computer—challenged my body.

"Stretch this apart as hard as you can," said Rhonda Goldman of Bodylog, Inc. (34 Maple Ave., Armonk, N.Y. 10504), as she handed me a bar with handles on each end. She smiled, I stretched, and the computer took note of my performance, calculating my maximum strength. Then, using the data, the computer had me pulling the handles apart once again—using a safe amount of exertion for my body—to raise a graphic helicopter over a building. Result: computer-controlled isometrics.

Add-ons are not the only thing new in computers. Commodore and Atari have PC-compatible models ["What's New in Electronics," this issue], and Amstrad is now distributing its British PC ["ENF," Jan.] in the United States. All the computers are in the $700 price range.

Computers are far from being the only devices that use digital electronics. Digital control and digital memories are creating entirely new kinds of features for video gear. For example, you use a light pen to program a new VCR from Toshiba. A menu of selections appears on the screen, and you use the pen to touch and pick the time and channels you'd like. For channel changers, there's a Panasonic VCR that lets you see up to four different scenes at once: The screen divides into four sections. The electronics in Magnavox's VHS-C camcorder can simulate a 1/1,000-second shutter. Result: Fast movements that ordinarily would be blurred during playback—such as a golf swing—are perfectly clear. Once you've made your home "movie" tape, new videotape editors from Sony, Showtime, and Vidicraft let you turn it into a nearly professional-looking recording. For a professional-*sounding* recording, Zenith has a full-size VHS camcorder that uses the VHS hi-fi system for recording high-quality stereo sound.

Digital audio tape (DAT) recorders appeared on the show floor, but were not yet for sale. A Sony demonstrator made that perfectly clear. When I covered my press badge and asked when the DATs would be available, his eyes glazed over and he began to speak as though he were a recording. "This is a prototype," he said in robotese. "We have absolutely no idea when the Sony digital audio tape recorder will be offered for sale." Rumors are that *somebody* will start selling a DAT by this August. (I suspect it could be as early as June.) Once one company does it, others are sure to follow.

Finally, despite all the high-tech hype, packaging seems to be one of the strongest selling points for this year's consumer electronics. For example, red, blue, and green TVs—to blend with any home setting—are typical. Yech, I thought. How can a *good* piece of electronic gear come in a red box? Then I saw a pink VCR from Panasonic... and began to think how well it would go with the curtains in my daughter's room. PS

NEW

Breakthrough Design Adjustable Socket Kit

U.S. AND FOREIGN PATENTS PENDING

This One Tool Replaces Twenty Sockets

No more need for a whole set of individual sockets. No more fishing around in your tool kit for the right size. This new CHANNELLOCK 906 Adjustable Socket does it all. Replaces 20 individual sockets. Fits 20 bolt or nut sizes, both metric and standard. Best of all —

- IT'S SIMPLE TO OPERATE. Just turn the knurled collar and the triple action jaws lock into a can't-slip grip on the bolt or nut as shown in illustrations.
- BUILT TO LAST. PRECISION MADE of high grade forged steel. Tough enough to withstand 1,200 inch lbs. of torque.
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- DOUBLES AS A NUT DRIVER. Just connect a 3/8" spinner handle onto the adjustable head.
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Place CHANNELLOCK 906 over nut or bolt. Rotate knurled collar to tightest fit. Triple action jaws close and lock into a can't-slip grip.

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Save Gas, Save Engine with **'POLY'**

The following introduces one of the most fully tested and credentialed gas saving, friction reducing engine treatments ever to reach the market!

WHAT IS POLY? "Poly" is short for polytetrafluoroethylene (TFE). It is the slipperiest substance known to man **(1981 Guiness Book of World Records, p. 188).** The PetroLon Corporation, makers of Slick 50, has invented a way to permanently bind this slippery chemical to your engine with one treatment. All you do is add one quart of Slick 50 to your oil during oil and filter change. By reducing engine friction, Slick 50 increases gas mileage and horsepower and reduces engine operating temperature thus causing your oil and engine to last longer. Just as important, it reduces metal wear, defraying costly overhauls.

HOW DO I KNOW THIS ISN'T A FRAUD? Slick 50 has some very impressive credentials. The **"Consumers Digest"** magazine (March/April 1982, p. 35) states "Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicate that it will improve gas mileage by about two or three miles per gallon.... Slick 50 does exactly what Petrolon claims it does." Researchers at a **nationally respected research laboratory**, after applying a powerful ultrasonic cleaning process to a Slick 50 treated engine part, were surprised at its permanence. They stated, "We actually expected the PetroLon Slick 50 TFE Resin coating to also be removed, but later found it was still there."

The **Federal Aviation Administration** has fully accepted a similar product- Slick 50 Aircraft Treatment (F.A.R. #33.49). An FAA test simulating 1400 hours of engine use (equivalent to about 70,000 miles on a car) showed almost zero engine wear!

"Dune Buggies and Hot VW's" magazine, April 1983, p. 70-71, records the results of their one year testing of Slick 50. "We can indeed say scientifically that Slick 50 does work and that it does reduce engine wear!.... for the price of one treatment when compared to engine rebuild, we feel you'd be money ahead using Slick 50."

A test done at the **San Diego State University** revealed that, "Slick 50 does increase horsepower and decreases fuel consumption in tests done at the university." The **Space Shuttle Columbia** uses the chemical "poly" in its gears and bearings because it is the only chemical lubricant which can withstand the heat and corrosive elements of space.

Perhaps the most dramatic of all is a

torture-test overseen by the **Automotive Services Council for Pennsylvania** and shown on television station WTVE. Three cars with between 75,000 and 129,000 miles on them were treated with Slick 50. Six months later the oil was drained from each vehicle and the cars were driven without the oil plugs for about a half hour. The water temperature never rose and the engines sustained no apparent damage. There are many more tests available. If you are still skeptical, send $2.00 to defray printing and postage costs and we will send you additional, more detailed, test information, etc.

HOW DO YOU TREAT AN ENGINE? Very simply. Just before oil and filter change, add engine flush (sent free with each order) to clean out your engine. Let your engine idle for 5 minutes. Then drain your oil, change filter and add the proper amount of oil less one quart. Add one quart Slick 50, drive for 30 minutes, and leave it in the crankcase for 3,000 miles. As the engine operates, the oil carries the "poly" between the parts where it is burnished into the pores of the metal. Once impregnated it is permanent, so **you do it only once**, not each time you change oil. One quart of Slick 50 will treat all standard 4, 6 and 8 cylinder gasoline and diesel engines.

WILL IT WORK WITH MOST OIL? Yes, Slick 50 will work with all petroleum based oils and all synthetics compatable with petroleum based oils.

WHAT ARE THE BENEFITS OF SLICK 50? Your actual benefits in percentages may vary, depending on the kind of driving you do, vehicle condition, etc. By reducing friction, Slick 50 does all of the following: it **increases gas mileage**. It **increases horsepower** -- small economy cars and large RV's really need this. It makes for **easier starting** (important in cold weather). It **reduces operating temperatures**, thus increasing the lubrication and life of your oil and your engine. Since lubricating lead is being removed from gas and unleaded gas is poor in lubricating qualities, the **extra lubrication of Slick 50 on valve stems and guides is very valuable**. Last, but not least, the drastic reduction in engine wear **defrays or eliminates costly overhauls** which can save you over $1,000. Slick 50 eliminates the "lubrication starvation" that all cars experience when first started before the oil has a chance to circulate. Up to 90% of the wear on a car can be caused by this lubrication starvation. You receive all of these benefits for **less than the cost of two tanks of gas** ($39.95).

WILL SLICK 50 HARM MY ENGINE OR AFFECT MY WARRANTY? No! Slick 50 is suspended in an excellent grade of petroleum oil which meets or exceeds every manufacturers engine warranty requirements. In addition, this oil carries an API (American Petroleum Institute) service classification SF-CC-CD.

DEALERSHIPS ARE AVAILABLE.

OTHER SLICK 50 PRODUCTS available are Gear Treatment (manual transmission, etc.), 2-Cycle Engine Treatment, Grease, Ultra 9 Oil, Fuel Conditioner, and Fabric Protector. Free information is sent upon request.

EASY TOLL FREE NUMBER. Since Slick 50 is **"too too Slick"** for engine friction, our toll free number is 1-800-22-SLICK (that is, 1-800-227-5425).

Free engine flush sent with each order. Free shipping with orders of 2 or more.

For purchase or further information call toll free 1-800-22-SLICK, (in Colorado, call 1-303-772-4797) or send to: FORT MORGAN SLICK 50, 407 Del Rio Road, Berthoud, Colorado 80513.

PS4

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The British

Britain's Sterling proves to be a strong challenger to the Mercedes-Benz 300E and Cadillac Seville. But this test raises a question: Just what mix of performance, quality, and comfort makes a car worth $25,000 or more?

BY TOM WILKINSON
Photos by Greg Sharko

It may be too early to start swinging lanterns from the belfry of the Old North Church, but another British invasion—this one automotive—is clearly underway.

First, Jaguar returned to health, and now Austin Rover, Great Britain's state-owned auto maker, is charging back into the American market. But the company that loosed millions of MGs and Austin-Healeys on American buyers is doing things differently this time. Its latest export, the Sterling, was designed in cooperation with Honda Motor Co. Indeed, under the skin, the Sterling and Acura Legend (another Honda venture) are practically twins.

The Sterling 825SL is the first of several new models coming from Austin Rover. But how good is this English samurai? To find out, the PS team tested it against the Mercedes-Benz 300E and Cadillac Seville. We chose the 300E because it is the bench mark for luxury sedans. As for the Seville, Sterling importer Norman Braman, a Cadillac dealer himself, has signed up many of the country's largest Cadillac dealers to sell the Sterling, putting the the two cars head to head in many showrooms across the U.S.

The test started out as a simple three-car comparison. But during our month with the cars, we kept bumping up against the same nagging question: Just what combination of performance, comfort, and quality leads one to shell out $25,000 or more

Continued

The Sterling (foreground), built by England's Austin Rover, will challenge the Mercedes-Benz 300E and Cadillac Seville in the American luxury market.

are coming!

One thing money can buy is better braking. The 300E, with its four-wheel discs and Bosch anti-lock braking system, stopped from 60 mph in just 123 ft.

for a mid-size sedan? Here's what we found.

Pedigree performance

When you pay a small fortune for a car, it should at least go, stop, and turn well enough to keep you from being embarrassed by some school kid with a Honda Civic. Although all three cars did well at the test strip, the $41,000 Mercedes proved to be the real champ.

The 300E was so quiet and smooth during the 0-to-60-mph runs that we were a bit shocked to find our times averaged a quick 8.7 seconds. The car also stopped incredibly well—its stops from 60 mph averaged just 123 feet. Better still, these short stops could be clicked off, one after another, by just standing on the brake pedal as hard as possible and letting the Bosch anti-lock brakes do the rest.

During our handling tests, the 300E felt solid and stable, though the actual speeds we recorded weren't that high, due in part to the narrow 195/65VR15 Michelin MXV radials. Mercedes has been criticized before for fitting its big sedans with narrow tires, but company engineers defend this decision. They told me they specify tires that will work well in all types of weather, not necessarily those that perform best on the track.

The Sterling shares its four-valve V6 engine and four-speed automatic transmission with the Acura Legend [PS, Aug. '86]. The two also share suspension and brakes, though spring and shock rates are different, and the Sterling 825SL comes with Bosch anti-lock as standard equipment. So it was no surprise that the performances of the Sterling and Legend were very similar, which is to say quite good. Zero-to-60 times for the Sterling averaged 10.7 seconds (versus 10.5 for the Acura). Stopping distance from 60 mph was 148 feet; that's six feet shorter than the Legend's, a difference we attribute to ABS. Handling-test times were close for both cars, and competitive with other sport sedans.

The Seville was equipped with the only V8 in the group. V8s were once a status symbol, but the 4.1-liter engine in the Cadillac was less powerful than the smaller sixes in the other cars, and the Seville was the slowest to 60 mph. Braking distance was respectable, but for $28,000, the car should have anti-lock. With its optional touring suspension, the Seville's handling on dry pavement was superb, though its wide Goodyear Eagle GTs wouldn't be my choice for wet or snowy roads.

We left the test strip satisfied that the performance of these cars won't embarrass their well-heeled buyers. But it was clear that, even in the case of the 300E, performance alone can't justify the price.

Leather and luxury

Perhaps comfort is what buyers of these cars pay for. Although the interior styling of the three is different (more on that later), interior space, trunk capacity, and ride quality were similar.

For starters, none of the trio is especially spacious. Put four six-footers in any of them, and someone is going to feel cramped. And families used to tossing two weeks' worth of suitcases into the back of a Mercury Grand Marquis are in for a rude shock the first time they pack for vacation. Still, with two or three people aboard, all three cars were a pleasure to travel in.

The designer of the Sterling told me Austin Rover intended to better the Legend in ride quality and interior fittings, and based on our test car, I think the design team succeeded. Firmer springs and shocks mean the Sterling floats less than the Acura on big bumps and dips, yet the suspension smooths small potholes and expansion joints quite well.

Inside, the Sterling follows the style set by Jaguar and Rolls Royce, with soft Connolly leather on the seats and

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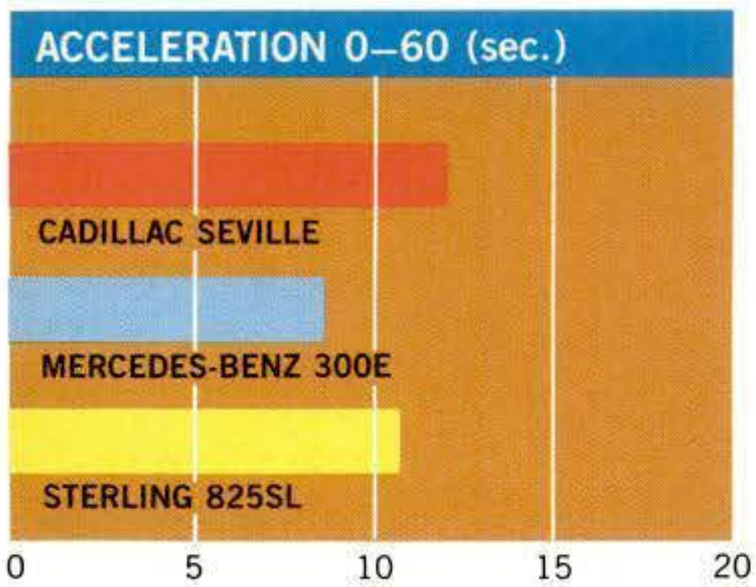

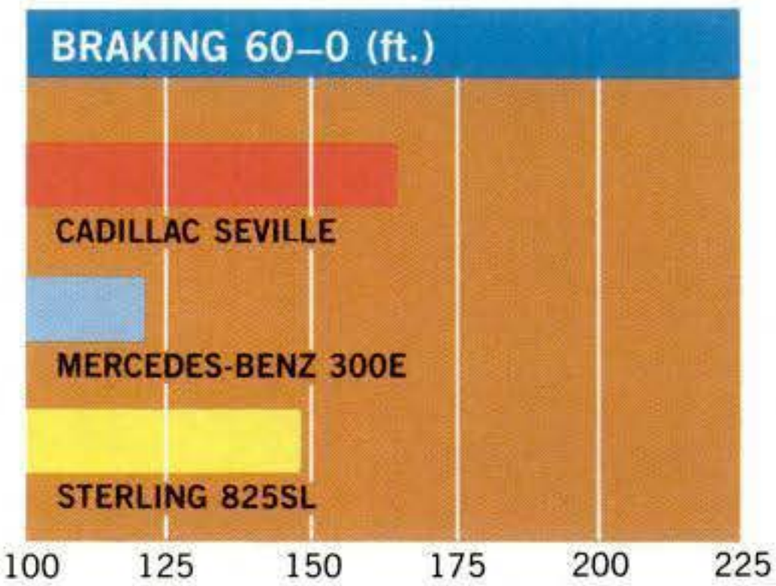

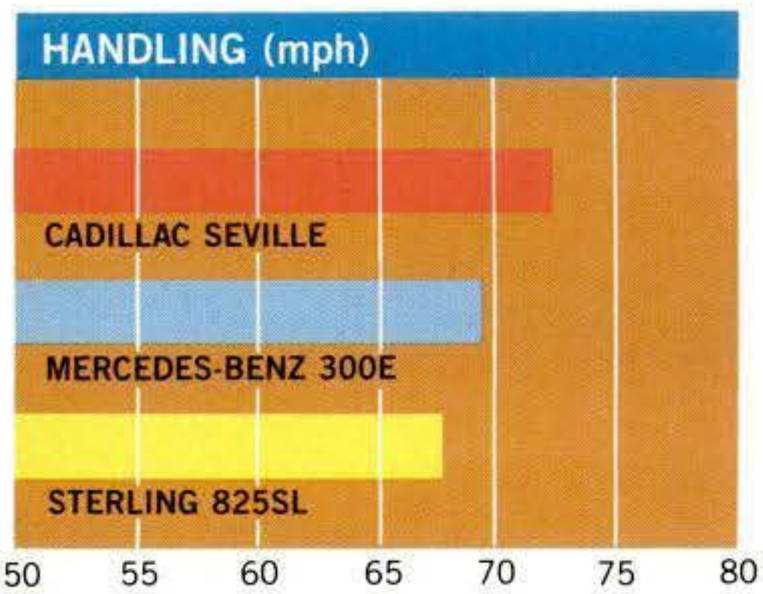

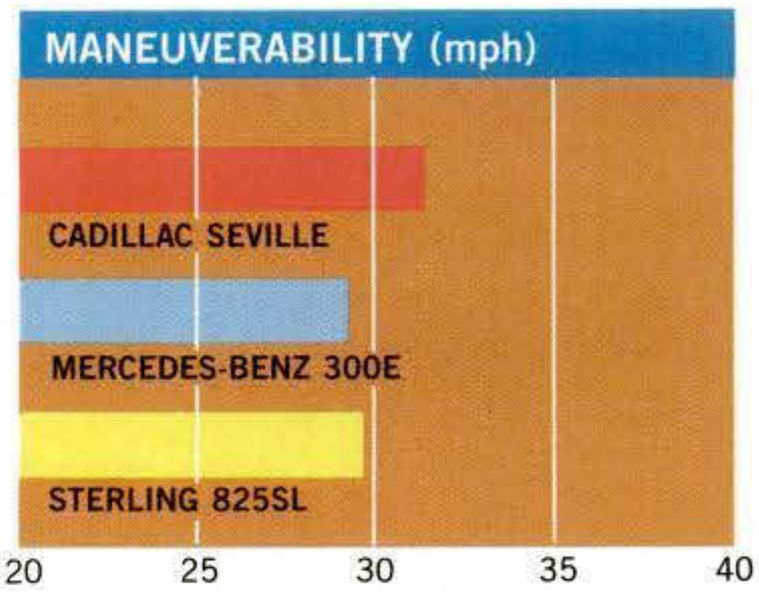

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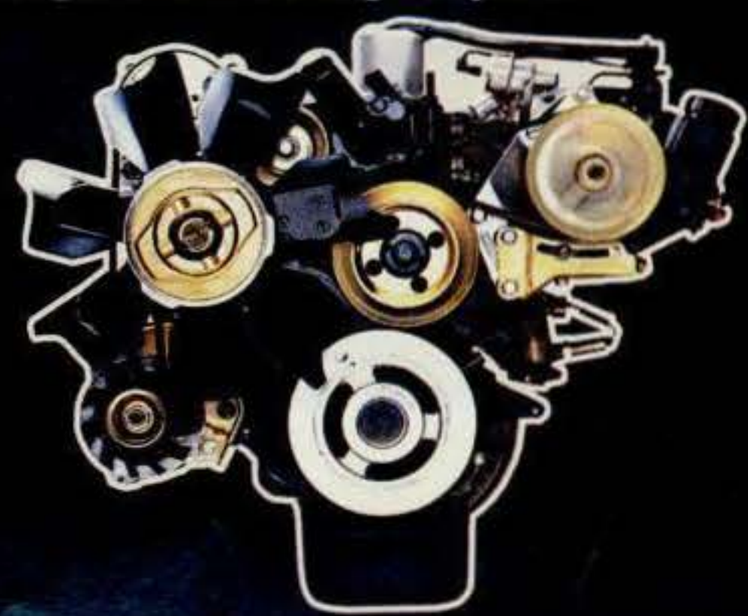
New Jeep Comanche SporTruck

$6495.* AND IT'S ALL JEEP.

1987 COMANCHE SPORTRUCK: It's not only the newest 2-wheel drive Comanche pickup, it's also the most affordable vehicle Jeep builds. At just $6,495, SporTruck has the most powerful standard engine of any truck in its class... delivering an impressive 121 horsepower. Plus, it's the only vehicle in its class with big 15-inch wheels and tires, standard.

POWER: This year, Comanche comes with an all-new optional 4.0 litre *Power-Tech Six* engine that puts out 173 horsepower and 220 foot-pounds of torque. That makes Comanche by far the most powerful truck of its kind.

A WIDE RANGE OF VEHICLES: Comanche gives you the choice of two-wheel drive or shift-on-the-fly four-wheel drive. And you can choose between the new shortbed model or longbed with the largest optional 4-wheel drive payload capacity of any truck in its class.



OTHER OPTIONS: Comanche already has a lot going for it. And there's a long list of available equipment that includes a responsive new 4-speed automatic transmission with overdrive.

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Jeep Comanche
Available in 2WD and 4WD

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POPULAR SCIENCE TEST RESULTS

TEST RESULTS	Cadillac Seville	Mercedes-Benz 300E	Sterling 825SL
Acceleration (sec.)			
0–30 mph	3.4	3.2	3.5
0–60 mph	12.1	8.7	10.7
Brake test 60–0 mph			
Stopping distance (ft.)	165	123	148
Pedal pressure, cold (lbs.) (0.5-G stop)	7	16	13
Pedal pressure, hot (lbs.) (0.5-G stop)	8	17	14
Handling test (mph)	72.4	69.6	67.9
Maneuverability test (mph)	31.4	29.3	29.7
Interior noise (dBA)			
At idle	44	42	44
At 60 mph	64	62	65
EPA FUEL MILEAGE (mpg)			
Highway	25	22	23
City	17	18	17

Dimensions and specs

DIMENSIONS (inches)			
Wheelbase	108.0	110.2	108.6
Overall length	188.0	187.2	188.8
Overall width	71.7	68.5	68.1
Overall height	53.7	56.9	54.8
SPECIFICATIONS (as tested)			
Engine type	V8	In-line 6	V6
Displacement (cu. in./liters)	250/4.1	181/3.0	152/2.5
Compression ratio	9.0:1	9.2:1	9.0:1
Induction	EFI	EFI	EFI
Net horsepower @ rpm	130 @ 4,200	177 @ 5,700	151 @ 5,800
Net torque (lb.-ft.) @ rpm	200 @ 2,200	188 @ 4,400	154 @ 4,500
Transmission	4-speed automatic	4-speed automatic	4-speed automatic
Final drive ratio	2.97:1	3.07:1	4.20:1
Steering	Power, rack and pinion	Power, recirculating ball	Power, rack and pinion
Turn diameter (ft.)	Left, 38.6 Right, 40.3	36.7	36.4
Front suspension	MacPherson struts with springs	Damper struts with coil springs	Double wishbone with coil springs
Rear suspension	MacPherson struts with coil springs	Multi-link with coil springs	Multi-link with coil springs
Brakes	Disc-disc	Disc-disc	Disc-disc
Curb weight (lbs.)	3,456	3,220	3,252
F/R weight distribution (%)	65/35	55/45	53/47
Fuel tank (gal.)	18.0	20.9	18.0
Trunk volume (cu. ft.)	14.1	14.6	12.1
Base price	$26,326	$39,500	$23,900
Price as tested	$28,814[1]	$41,770[2]	$24,195[3]

Major options: [1]Leather seats $410, power seat recliners $345, electronic radio $329, touring suspension $155; [2]leather seats $1,285, sun roof $435, orthopedic seats $275 each; [3]power rear seat $295

Parts and service

PART PRICES (manufacturers' suggested retail)			
Brake pads, front	*	$ 48	$ 70
Brake pads/linings, rear	*	24	51
Front shock/strut insert	$ 95	106	46
Alternator	192	229	221
Fuel pump	87	183	135
Ignition module	*	699	155
Grille	46	170[1]	24
Front bumper	426	227	173
Windshield	1,109[2]	204	191
Taillight lens	51	56	67

*Cadillac does not list suggested retail price; [1]less star; [2]special plastic-coated anti-lacerative design

PS serviceability ratings

Checking oil level	5	5	5
Checking coolant level	5	5	5
Adding oil	5	5	5
Changing oil filter	2	4	2
Changing spark plugs	2	5	3
Changing belts	3	2	1
Changing radiator hoses	2	4	3
Changing heater hoses	2	3	3
Checking fuses	5	4	4
Spare-tire access	3	4	3

(Ease of service: 5 = excellent, 1 = poor)

slabs of burled walnut everywhere. If only it had round, white-on-black Smiths gauges. As it is, the instrument cluster, though plastic, is easy to read. And except for the tiny headlight switch awkwardly placed atop the turn-signal stalk, the controls were logically placed.

By flaunting its engineering skill rather than its carpentry and leatherworking, Mercedes has helped change many Americans' ideas of what a luxury car should be. The 300E, for example, was almost painfully austere inside. The giant plastic steering wheel looked like something from a van, but the steering was so steady on-center that the 300E felt as if it were on rails. And though it was the lightest car in the group, the Mercedes felt the most substantial.

The gauges and controls worked perfectly, and the seats proved comfortable for day-long drives. If only I could figure out how Mercedes makes leather upholstery look and smell like vinyl. Finally, the 300E had a driver-side air bag, and automatic belt tensioners were provided for both front seats. These advanced safety features are available on few other cars. We had only one complaint about the 300E's manners: On cold days, the automatic climate control maintained the set temperature by periodically blasting the interior with hot air, rather than by quietly blending hot and cool air.

The Seville lacked the tradition of the Sterling and the integrity of the Benz, but it sure had a great air conditioner. Both heating and cooling worked flawlessly, and unlike the noisy fans in the 300E and Sterling, that in the Seville was almost silent.

The Seville has other strengths as well. Its touring suspension was a good compromise between comfort and handling; the ride was much like that of the Sterling or 300E, a far cry from Cadillacs past. Inside, the leather bucket seats were comfortable, and their thin backs and tiny headrests made the back seat seem less claustrophobic than those of the 300E or Sterling.

On the minus side, most drivers didn't care for the digital instruments or for the chrome buttons and skinny stalks that pass for controls. And although the plastic anti-lacerative coating on the inside of the windshield would have been nice in an accident, it produced annoying reflections off the top of the instrument panel; also, its replacement cost is staggering.

Question of quality

Given the wretched quality of previous British cars, we were generally

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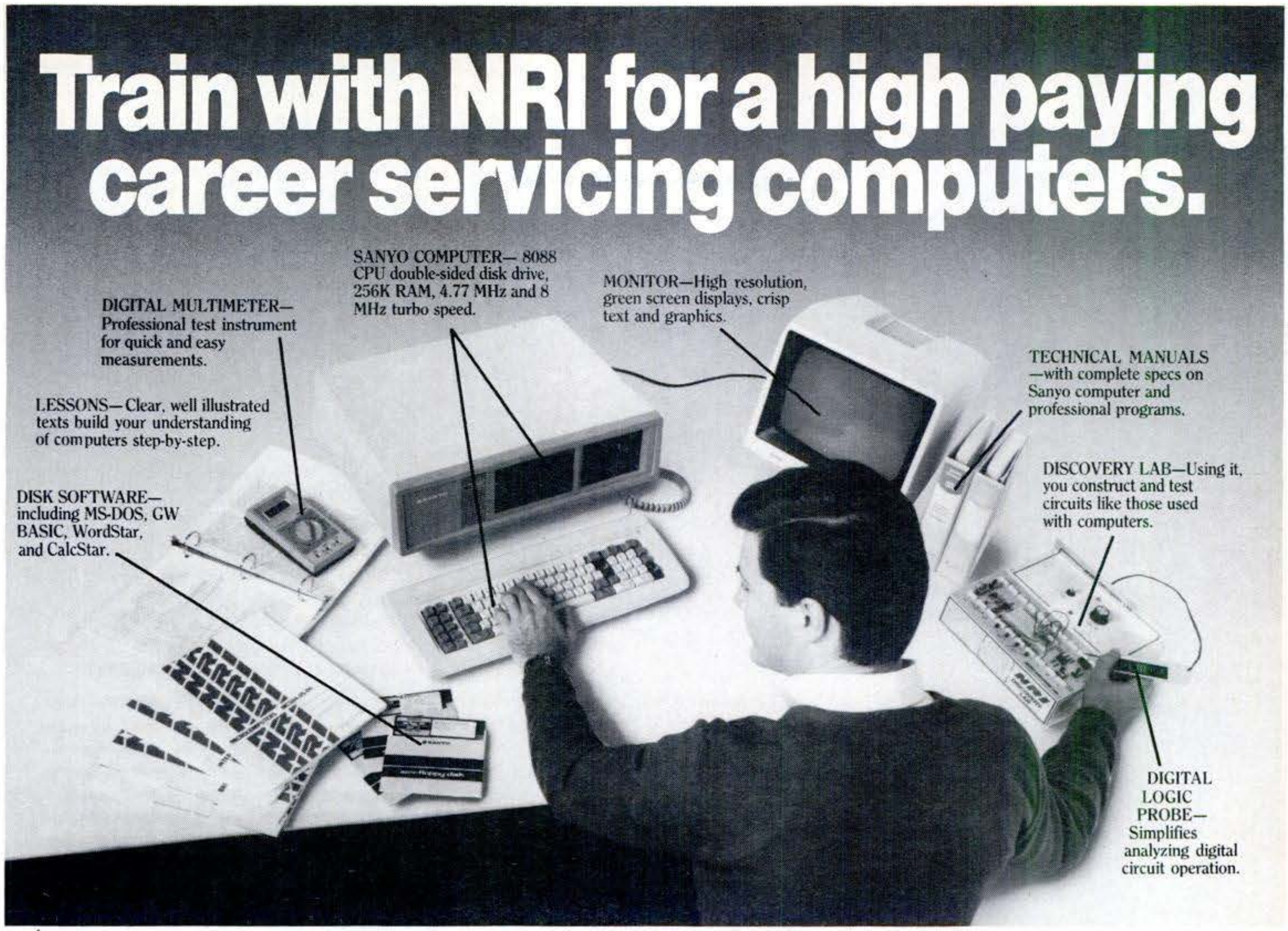

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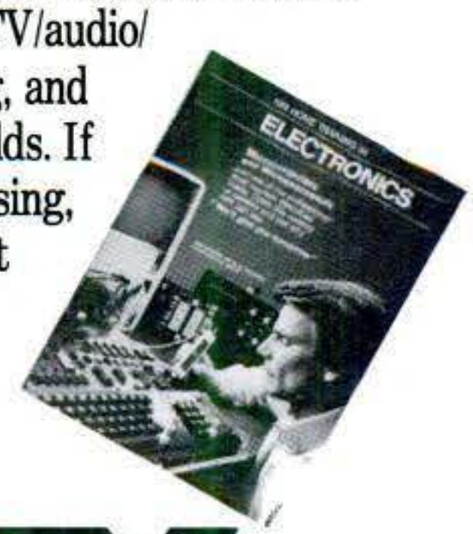

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pleased with the way the early-production Sterling was screwed together. A few of the interior trim pieces didn't fit quite right, and a problem in one of the power door locks set the burglar alarm off. A Sterling spokesman assured us that these bugs are now worked out, and given that Sterlings and Legends are being built on the same assembly line in England, I'm willing to give Sterling the benefit of the doubt.

The Mercedes was as solid as a safe, and except for the cantankerous temperature control, we detected no flaws in the car anywhere. And we were pleasantly surprised by the Seville, which felt exceptionally tight and solid. (This is the fourth new General Motors car we've tested that's felt this way. Could this be a trend?)

Price of prestige

After a month of testing, the PS drivers were convinced that the Sterling should do well in the luxury class. But we were as uncertain as ever about what makes it, or either of the other cars in the group, worth $25,000 or more.

Except for the awesome braking provided by the two ABS systems, the performance provided by the cars in this trio can be duplicated for considerably less money. Similar levels of comfort and convenience are also available in less-costly cars. What's left, then, is something hard to measure, something special about each vehicle that people who sell luxury cars often call "prestige."

The 300E, for instance, is the sort of sedan you'd get if you told a group of middle-aged German engineers to build their dream car—which is pretty much what Daimler-Benz does. The 300E has an integrity of design and assembly you won't find in many mass-produced machines. True, mechanical perfection isn't everybody's idea of luxury, but Mercedes still sold almost 90,000 cars here last year, the cheapest of which, the 190E 2.3, costs $25,000 plus.

While Mercedes begins in the engineering lab, Cadillac seems tied to the styling studio. For the Seville, the traditional Cadillac rectangular theme is scaled down a bit, then the car is crammed with electronic gewgaws. And though the Seville is quiet, comfortable, and a good performer, Cadillac buyers have shunned it. Perhaps this is because the car looks small and insubstantial, despite the fact that it's longer, wider, and heavier than the 300E.

The Sterling seems to benefit from its British-Japanese parentage. True, the exterior styling is ho-hum at best; at one point during our testing, I was trying to follow the Sterling on a crowded highway, and found myself instead behind a Toyota Camry. But the interior was quiet and elegant in a very British way, and the Honda-designed drive train worked just about perfectly. For those who want the feel of a Jaguar but can't quite afford it, England's newest export may be right on target.

Author's pick

I love the 300E. But the high price tags keep me from recommending any of these three cars to most buyers. If you can live without leather, a well-equipped Taurus or an Accord LXi will serve almost as well as the Mercedes, Sterling, or Seville. You'll end up with a less-prestigious car, but you'll have enough change in your pocket for a Hyundai or two. PS

View from the driver's seat

Old-fashioned luxury cars were expected to do three things well: ride smoothly, cruise silently, and provide room inside for a rolling board meeting. Times change. This trio of luxury cruisers are members of a leaner breed, also expected to provide exciting performance. This they did—sometimes at the expense of the old-fashioned virtues.

The Cadillac Seville blasted through the handling tests like a Z28 Camaro. Cadillac traditionalists may think it rides just as harshly. Its V8 engine was the largest in the group, and produced plenty of low-end torque for quick launches. But keep the pedal down, and acceleration just trails off. Perhaps the biggest problem is that the Seville lacks the prestige and charm that an expensive car must have. Instead, it seems to be just another GM-built appliance.

The Mercedes 300E presents a strong argument in favor of cars that cost $40,000 or more, and does it without the chrome plating, air-cushion ride, or land-yacht size that once defined luxury sedans. Its unyielding body structure and sophisticated independent suspension gobbled up rough roads, yet delivered a remarkably comfortable ride. The 300E's in-line six was as smooth and quiet as a V12, and its anti-lock brakes slowed the car as if it had snagged an arresting hook. Only the interior lacked luxury-car credentials. Its Teutonic starkness seemed cold, and the rear bench was too narrow to comfortably accommodate three adults for a long trip.

If you can't quite afford a Jaguar XJ6 but desire the silence, quickness, and comfort of the big British cat, take a look at the Sterling. The chassis was solid, with an opulent heft to it. The suspension provided a supple ride and precise handling. And the Honda-built 2.5-liter V6 delivered quick and quiet power through a four-speed automatic.

Unfortunately, the Sterling interior didn't measure up completely. The test car had a tad too much cheap-looking plastic, the column stalks wobbled, and the center console rocked back and forth annoyingly.

If I won the lottery, I'd be happy with a 300E.—*Jack Keebler*

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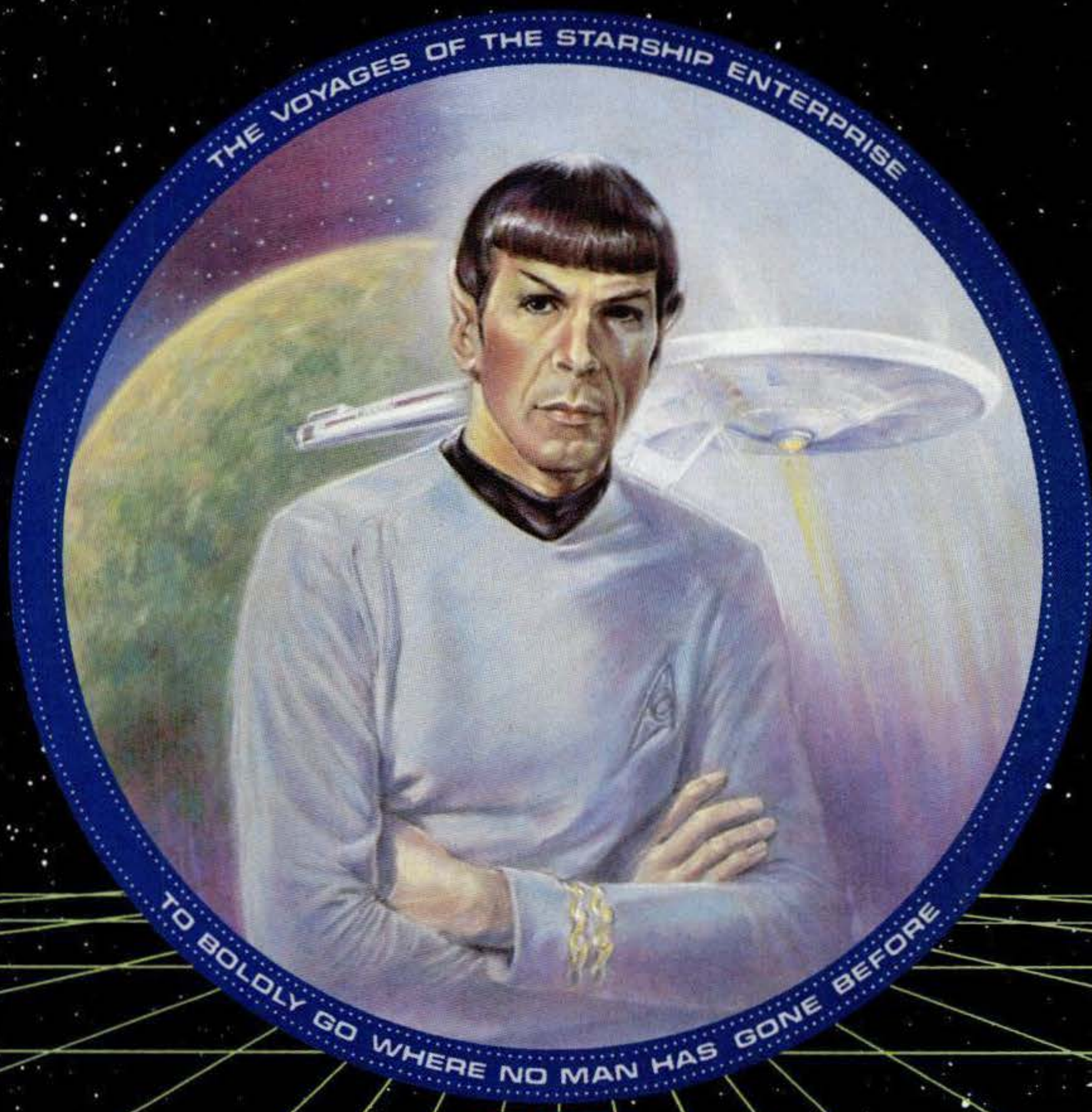

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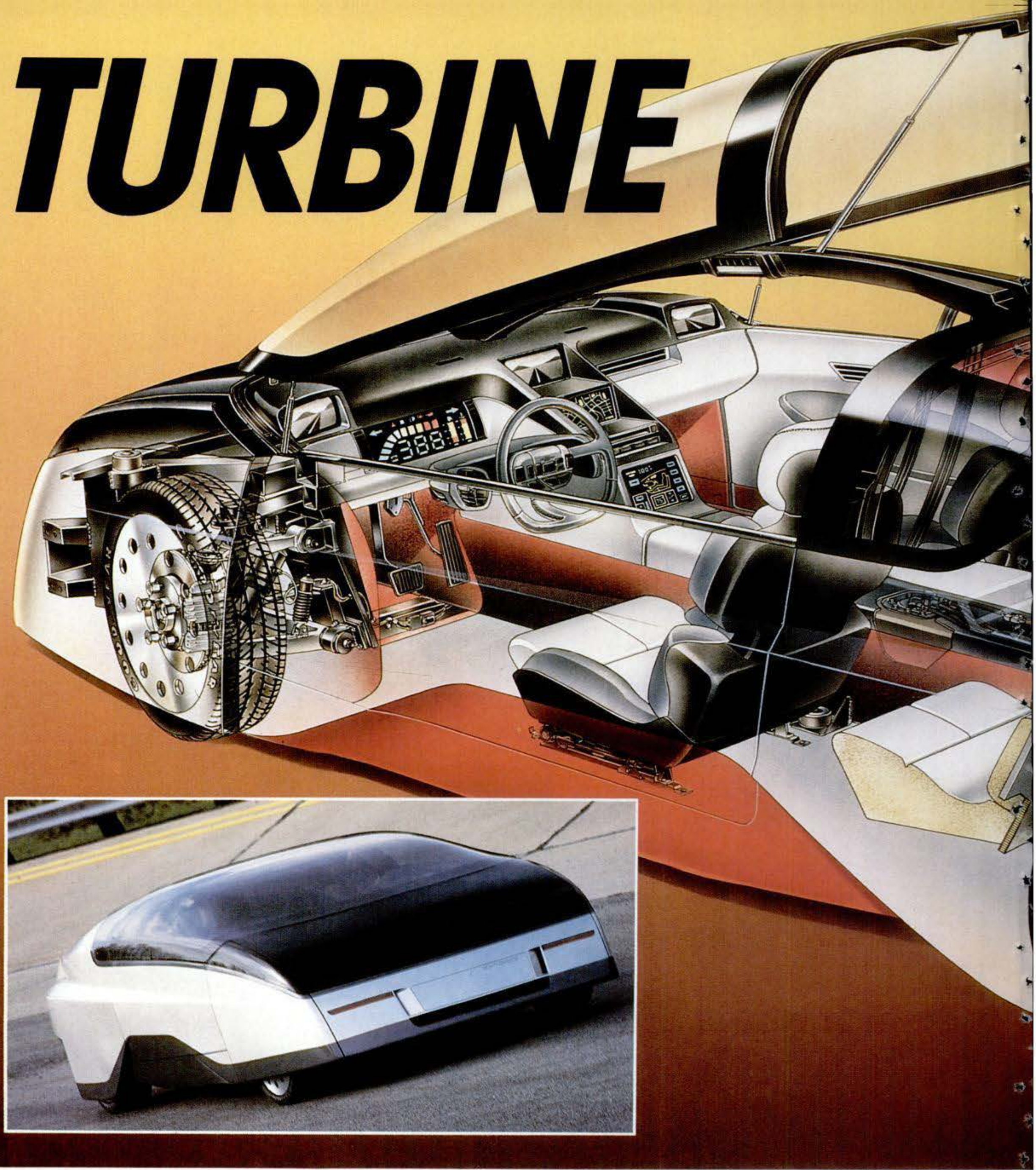

The highly aerodynamic gas-turbine-powered Chevrolet Express is capable of running at a sustained 150 miles per hour.

By DAN McCOSH *Detroit Editor*

Could a passenger car successfully compete with short-haul aircraft for high-speed, inter-city transportation? If speed were the only consideration, a few of today's high-performance sports cars could provide an affirmative answer. Even a Ferrari bogs down in traffic, however.

General Motors' Chevrolet-Pontiac-Canada (CPC) Advanced Engineering Department attacked the premise by visualizing a specialized, high-speed highway network built on abandoned railroad rights-of-way. Free of traffic and legal restraints, the Chevy Express would be capable of sustained 150-mph speeds while sipping about a gallon of kerosene every 20 miles.

That kind of performance would make an easy end run

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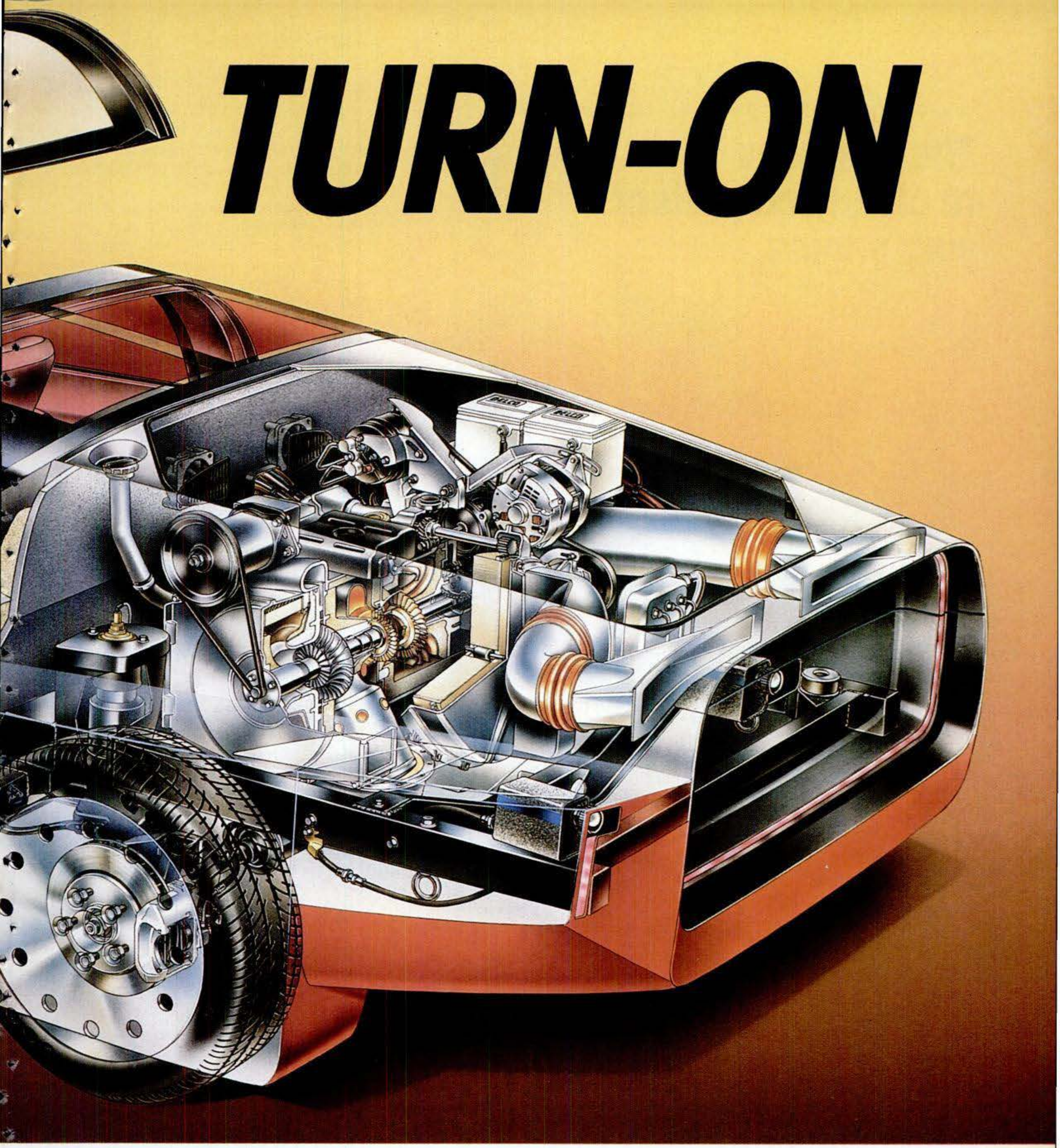
TURN-ON



around most of today's congested air terminals. To achieve it, engineers and designers at GM's Advanced Concept Center in California and CPC's Advanced Engineering Department recently unveiled a slippery, four-passenger car powered by a rear-mounted gas turbine. In contrast to turbocharged engines, which enjoy tremendous popularity these days, pure gas turbines have generated little interest lately. But the Express is the latest in a long series of GM concept vehicles that have attempted to adapt the popular aircraft engine to an automobile.

The Chevy Express is powered by GM's AGT-5, a gas turbine that generates about 120 horsepower and 350 pound-feet of torque. A new ceramic regenerator is expected to boost the engine to about 150 hp later this summer, say GM engineers. A gas turbine works something like a jet engine blowing against a fan that drives the car's wheels. It is a continuous-combustion engine that burns with little pollution and provides ample low-speed torque.

GM has been showing experimental gas-turbine cars for more than 20 years, dating back to a 370-hp XP 21

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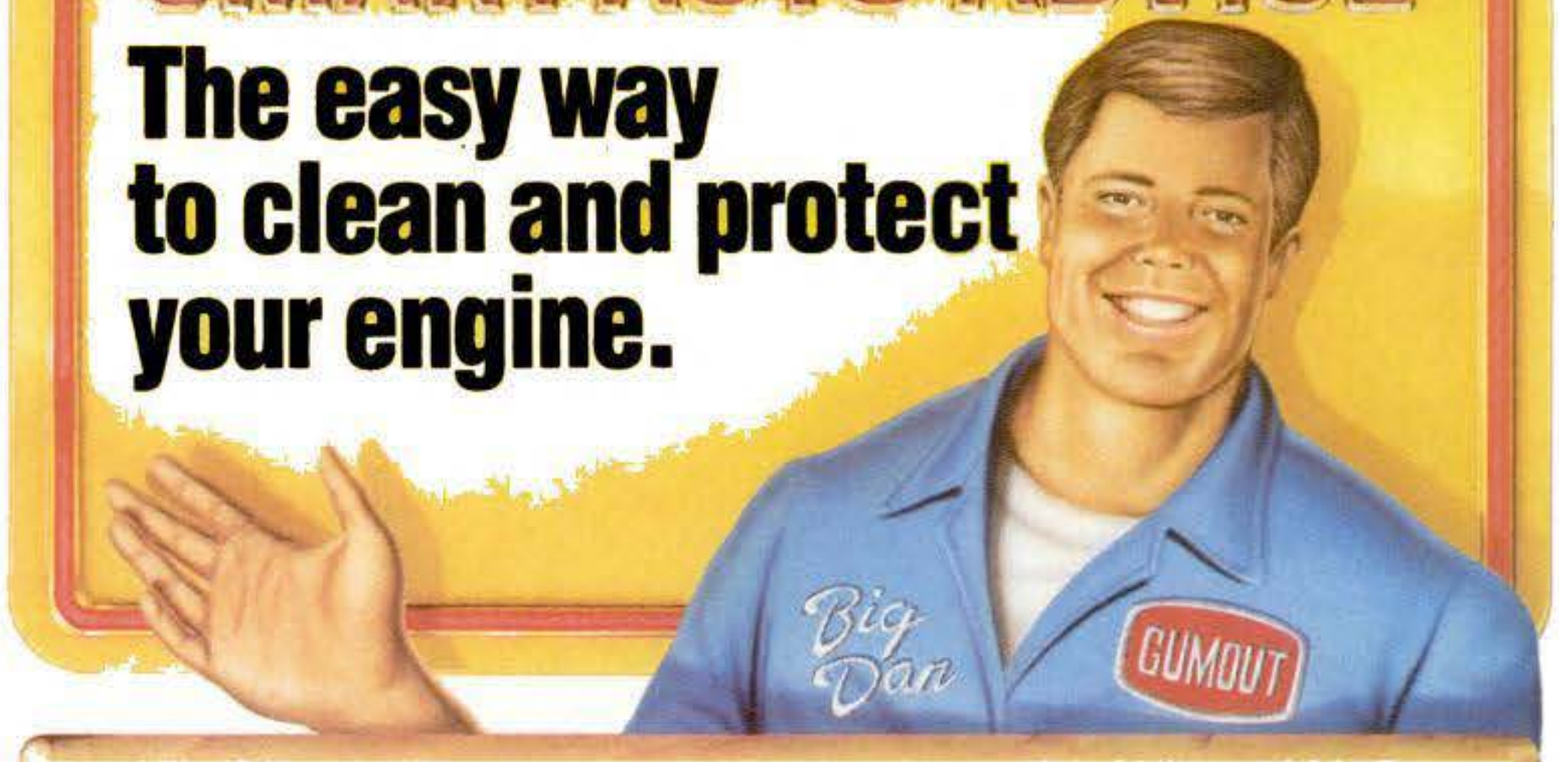

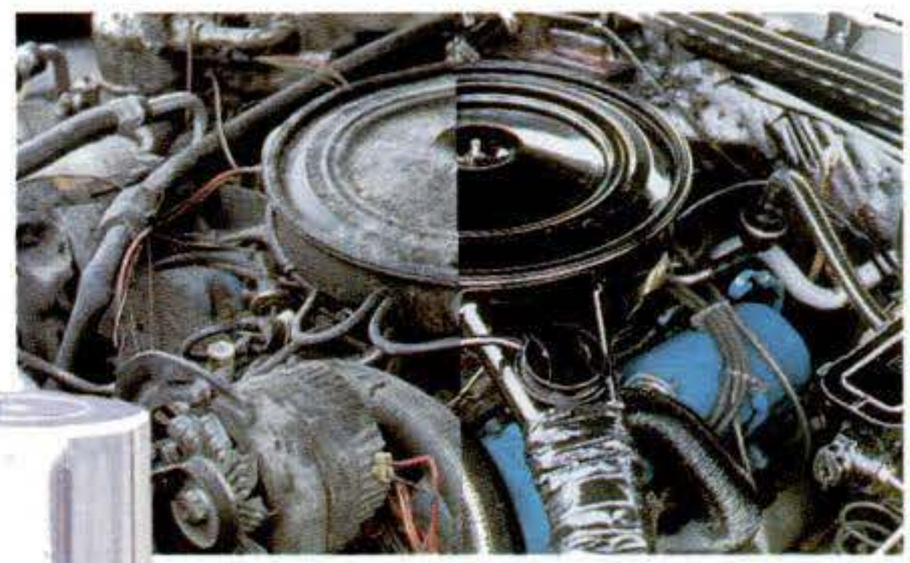

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Turbine turn-on *Continued*

Firebird that roasted bystanders with its hot exhaust in 1955. A regenerator on the latest AGT-5 has cooled exhaust temperatures on the Chevy Express to where engineers use it to warm their hands during cold-weather testing.

Although the gas-turbine project is out of the research stage, it may be a while before turbines reach consumers. The thermodynamic efficiency of a gas turbine is still less than that of an equivalent piston engine, says Albert H. Bell, executive engineer in charge of the ACT-5.

"The problem is the temperature ratio between the inlet and exhaust at ground level," says Bell. "Airplanes fly at minus sixty-five degrees. We have to raise the operating temperature to get the same ratio for a car, and that means more ceramics."

Ironically, according to Bell, the acceptance of the turbocharger has helped the gas turbine. "We're used to speeds of 80,000 rpm now," he says. (That's the operating speed of both a turbocharger and a gas turbine.) "High speed doesn't necessarily mean it's expensive, either," adds Bell. "It makes the parts smaller."

Technology showpiece

Gas turbine aside, the Chevy Express is a walk-through of some of the latest technology at GM engineering. The car's structure is bonded steel and graphite-fiber-reinforced plastic for light weight and extreme strength.

Its suspension is an integrated air-spring damper that replaces conventional springs and shocks. The suspension also allows adjustable ride height—a key to achieving the car's low drag coefficient of 0.19.

Steering is done with a hybrid hydraulic-electric power rack-and-pinion system, a unit that combines some of the effectiveness of electric power steering [PS, May '86] with the solid feel of today's hydraulics. The steering system is similar to a production unit being developed by GM.

Other details are further out. A multiplexed electrical system, for example, works off a continuous loop that carries computer commands to all points in the car. There is no direct mechanical connection between the gas pedal and the engine: Instead, pressure on the pedal sends a computer signal to the electronic system that controls the engine.

The Chevy Express is a thought-provoking expression of new ideas in advanced technology. But unlike most such concept vehicles, it is fully worked out and drivable—an indication that many of its features may not be as far out as they appear. PS

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Radar warning breakthrough #4 is now available from the same engineers who made #1, #2, and #3

Bad news for radar detectors. The FCC (Federal Communications Commission) has cleared the Rashid VRSS for operation on K band.

What's a Rashid VRSS?

The Rashid VRSS is a collision warning system using a radar beam to scan the vehicle's path, much as a blind person uses a cane. It may reduce accidents, which is very good news.*

Now for the bad news

Unfortunately, the Rashid transmits on K band, which is one of the frequencies assigned to traffic radar. Rashid speaks a radar detector's language, you might say, and it can set off detectors over a mile away.

Faced with this problem, we could hope Rashid installations will be few. Or we could invent a solution.

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Actually, the choice was easier than it sounds, because our engineers are in the habit of inventing remarkable solutions. In fact, in the history of radar detection, only three advancements have qualified as genuine breakthroughs, and all three came from our engineers.

Back in 1978, they were first to adapt dual-band superheterodyne technology to the problem of traffic radar. The result was ESCORT, now legendary for its performance.

In 1983, when a deluge of cheap imported detectors was found to be transmitting on radar frequency, our engineers came through again, this time with ST/O/P™, a sophisticated circuit that could weed out these phony signals before they triggered an alarm.

Then in 1984, using SMDs (Surface Mounted Devices), micro-electronics originally intended for satellites, these same engineers designed the smallest detector ever. The result was PASSPORT, renowned for its convenience.

*For more information on Rashid VRSS collision warning system, see *Popular Science*, January 1986.

They said it couldn't be done

Now we're introducing breakthrough number four. In their cleverest innovation yet, our engineers have found a way to distinguish Rashid from all other K band signals. It's the electronic equivalent of finding the needle in a haystack. The AFR™ (Alternating Frequency Rejection) circuit isolates and neutralizes all Rashid signals, yet leaves the radar detection capability undiminished for your protection.

No waiting for the good stuff

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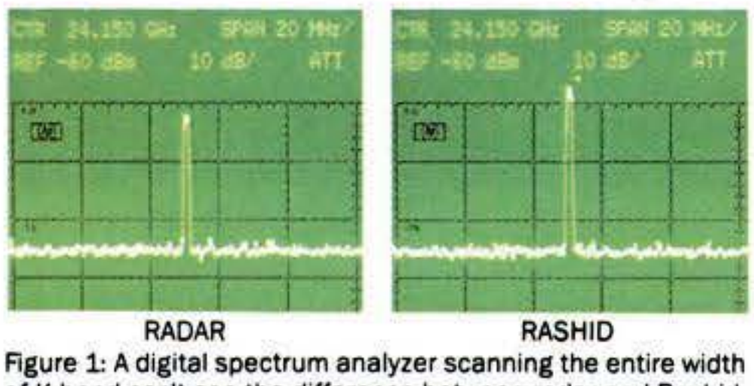

Figure 1: A digital spectrum analyzer scanning the entire width of K band can't see the difference between radar and Rashid.

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Popular Science

What's News

Slippery sloop

The February issue of POPULAR SCIENCE contained an article detailing much of the ingenious high-tech engineering that went into the design of the various America's Cup contenders. Now, a new and hitherto unknown item: On Jan. 2, U.S. contender *Stars and Stripes* beat *USA* for the fourth time to win a spot in the semifinal round of the elimination races. *USA* skipper Tom Blackaller commented afterward that skipper Dennis Conner of *Stars and Stripes* seemed to have found some mysterious burst of speed that allowed him to take the race so effortlessly. He knew not how truly he spoke. Although it was a closely guarded secret at the time, Conner had acquired a new skin for the hull of *Stars and Stripes* and had it secretly applied on Dec. 26. The skin grew out of a hot new development in aeronautics. The article on next-generation airliners in this issue tells how engineers are considering including riblets —thin grooves cut into the skin of an airliner parallel to the direction of airflow—in their designs. For reasons not understood, riblets smooth the flow of air and reduce drag.

Cut to Minneapolis. For some time now, 3M Co. has been working on the NASA-originated riblet technology, and had developed a plastic film with tiny grooves in it. Conner learned of the development, got hold of some of the film, and had it secretly installed.

Just how much help it gave his boat is unknown. A Boeing engineer knowledgeable on the subject said riblets may reduce drag in air by six to eight percent. Whatever advantage they gave Conner in the water was apparently enough. With the new skin in place, he was able to beat *USA*, then go on to skunk the New Zealand boat widely known as Kiwi Magic (because it had seemed nearly invincible until it was pitted against *Stars and Stripes*). Did riblets give Conner the edge he needed to trounce the Australians in that incredible stretch of victories during which the defenders never even provided serious competition? Stay tuned. We'll try to find out.

CVT at last

A continuously variable automatic transmission would have tremendous advantages. It would constantly balance engine torque, road conditions, and throttle position, and produce the ideal—and constantly changing—gear ratio between engine and driving wheels. You would get maximum performance and maximum fuel economy. The transmission would also eliminate energy-wasting slippage that plagues present automatic-transmission torque converters, and would eliminate the jerking now present when the automatic transmission suddenly shifts gears in response to changing throttle position or driving conditions.

A device with this many advantages would have been in cars years ago had there not been serious technical problems. A number of articles in POPULAR SCIENCE over the last decade have detailed some of the engineering efforts aimed at solving them. Now, finally, several almost-simultaneous developments: The Subaru Justy equipped with a CVT went on the market in Japan on Feb. 1. The price of the three-door model was the equivalent of approximately $6,100—about the same as a similar car with a conventional automatic. Subaru says that the Justy will go on the market in the U.S. at some unspecified later date.

At the same time, Ford Motor Co. is set to begin production in Europe of a CVT-equipped small front-wheel-drive vehicle—probably the Fiesta—in mid-1987. Fiat will begin producing a CVT car a little later.

One surprising fact: All of these cars will use essentially the same CVT —one developed by the Netherlands-based company, van Doorne's Transmissie BV. Ford and other companies have cooperated in and invested heavily in CVT development in recent years. The transmission works on a simple principle: A metal-link belt connects two pulleys, transmitting energy from one to the other. Each pulley is made of two movable plates. The plates can be moved closer together or farther apart so that the effective diameter of the pulley can be changed. Because both pulleys are continuously variable in size, you can go from a low gear ratio with one pulley at its minimum size and the other at maximum, to a high ratio with the pulleys in the opposite configuration—or anywhere in between.

Though CVT seems simple in principle, turning it into a mass-produced product has been one headache after another. The big hang-up has been mass production of a critical component, a metal-link belt that would last long enough to put into a car. First to accomplish this was apparently Fuji Heavy Industries—maker of Subaru cars—since Subaru is first on the market. Fuji, incidentally, will supply transmissions for Fiat. Ford, on the other hand, has invested to date $120 million in CVT tooling at its transmission plant in Bordeaux, France, and will apparently soon switch all production to that site.

One big player missing from the current game is General Motors Corp. GM had been planning to produce a somewhat different CVT containing, among other things, electronic controls at its plant in Strasbourg, France. The GM transmission is a little bigger, however, for use with larger engines. And the belt design problem has not been completely solved, although GM is now reported to be testing a belt made by Borg-Warner.

But despite the immediate problems, it seems obvious that this significant—and long-awaited—new trend in car design is at last on the verge of commercial production.

Editor-in-Chief

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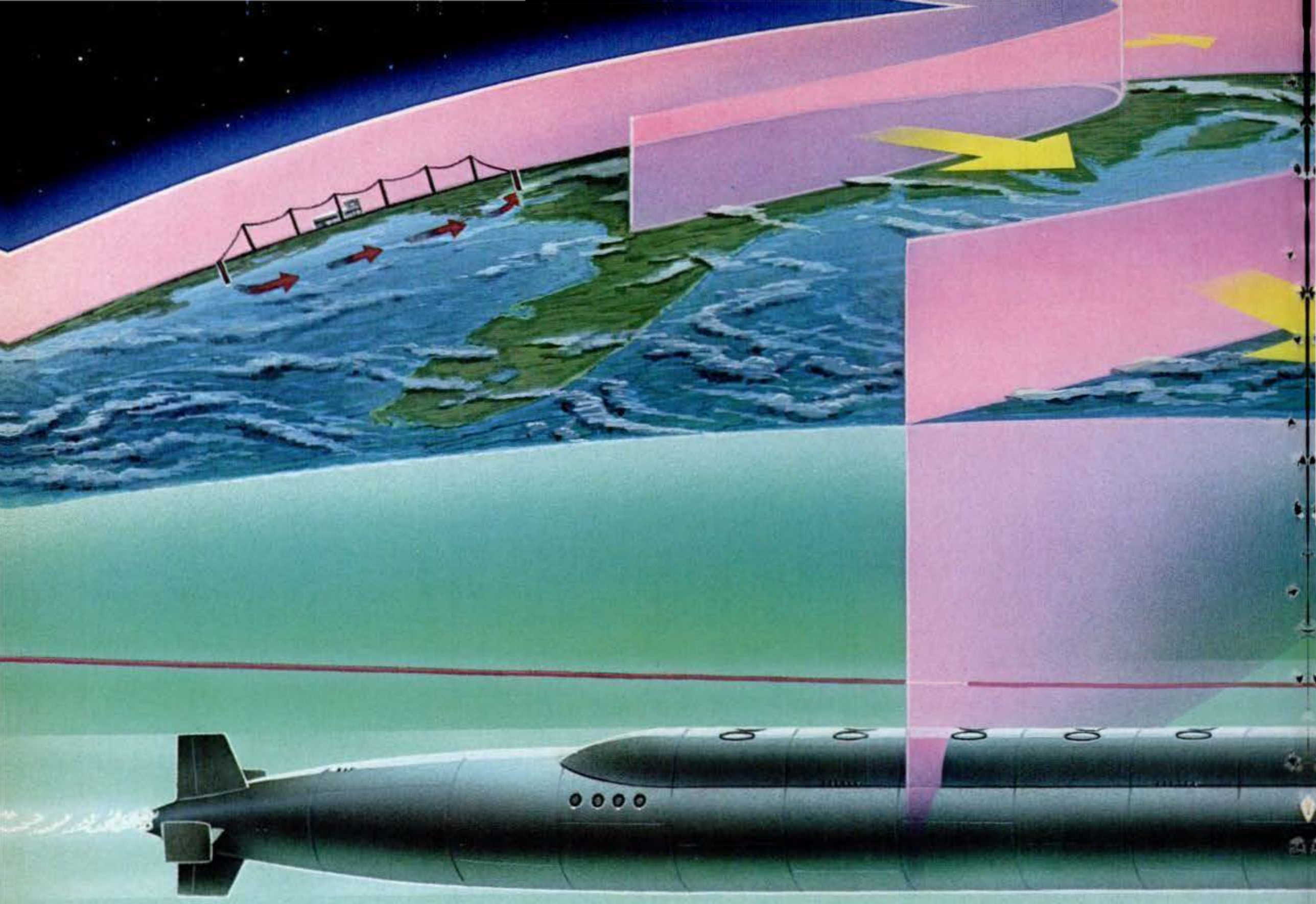

SIGNALING SUBS

Navy submarines must rise to the ocean's surface at preset times to receive radio communications, but such rendezvous can give away their strategic positions. Now subs can stay hidden longer, receiving extremely low frequency radio waves from giant transmitters that issue abbreviated commands. Eventually, subs may get all their signals from orbiting satellites that beam blue laser light deep into the ocean.

By T. A. HEPPENHEIMER
Painting by Jeff Mangiat

The North Atlantic is fearsome in winter. Sleet slants down from thick cloud banks scudding low above the empty gray sea. The torrents slash through windblown spray as the storm raises enormous swells. Hundreds of feet below the surface, a submarine slowly, quietly heads north.

From its polar orbit in space, a satellite shoots a deep-blue laser beam downward. It quickly spreads to form a broad spot. If this were nighttime, the spot would show dimly at the tops of the clouds, but in the early afternoon the sun's glare hides it. The laser beam scans back and forth, plunging through the churning waves deep into the sea, where it sweeps over the submarine and passes onward.

Aboard the sub, a communications officer watches as her computer terminal lights up. Quickly she sends the coded message to its intended recipient, the ship's executive officer. His own computer soon shows the decoded command: U.S.S. DALLAS, PROCEED TO SECTOR C. He issues a rudder order; the sub slowly turns. Now it will patrol closer to the Soviet Union.

Until recently, subs had to rise to the surface at appointed times to listen for radio messages from circling airplanes in the older TACAMO (Take Charge and Move Out) system. Now, two new signaling systems will allow subs to receive instructions without interrupting their deep patrols. One, already in operation, is a million-watt-plus extremely low frequency (ELF) radio transmitter that can relay messages to subs throughout the world (see captions, right and next page). Its coded three-letter commands tell subs when and where it's safe to come up for more-detailed messages. The second system, using blue laser light, will relay more-complex signals, making

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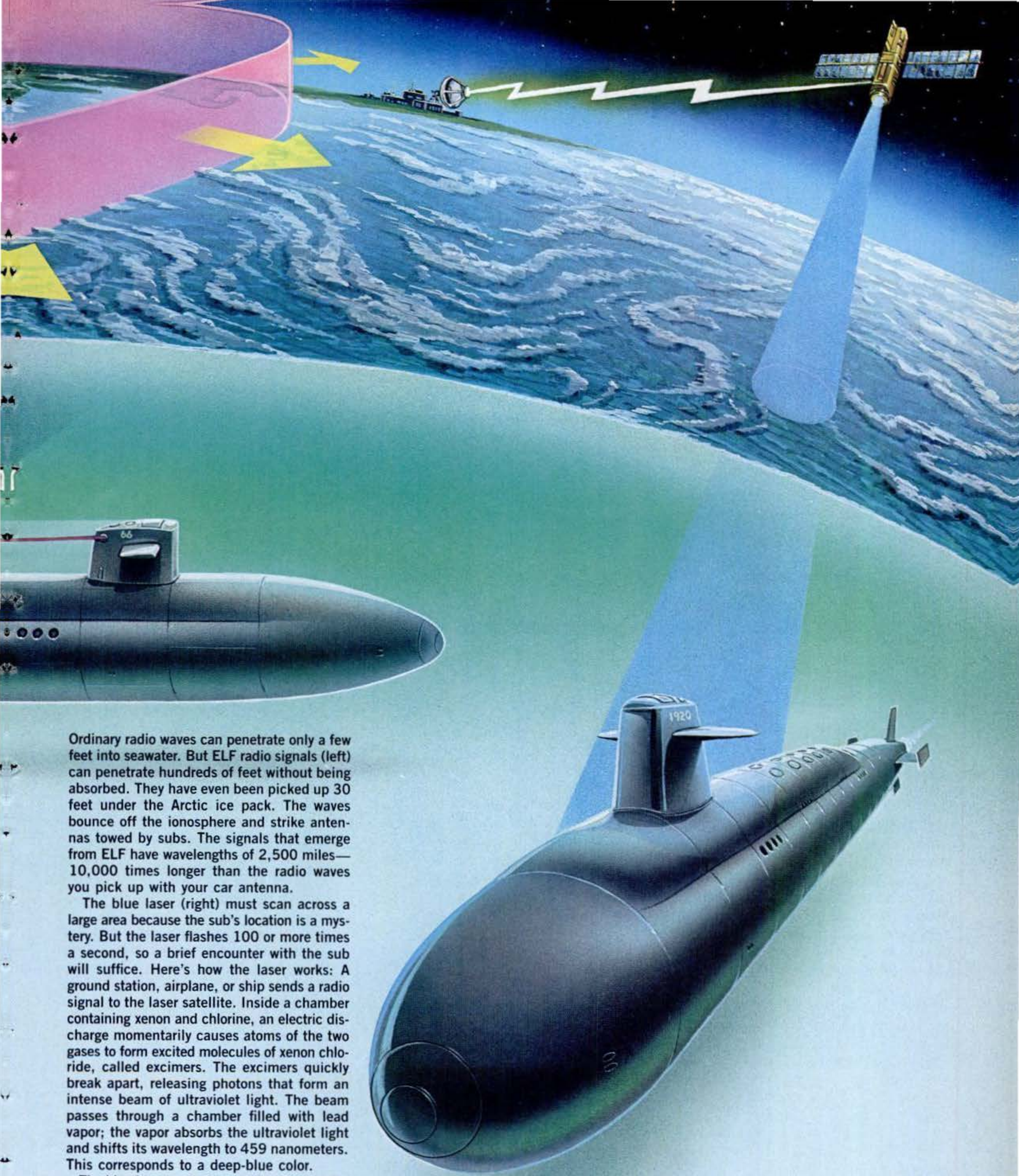

Ordinary radio waves can penetrate only a few feet into seawater. But ELF radio signals (left) can penetrate hundreds of feet without being absorbed. They have even been picked up 30 feet under the Arctic ice pack. The waves bounce off the ionosphere and strike antennas towed by subs. The signals that emerge from ELF have wavelengths of 2,500 miles—10,000 times longer than the radio waves you pick up with your car antenna.

The blue laser (right) must scan across a large area because the sub's location is a mystery. But the laser flashes 100 or more times a second, so a brief encounter with the sub will suffice. Here's how the laser works: A ground station, airplane, or ship sends a radio signal to the laser satellite. Inside a chamber containing xenon and chlorine, an electric discharge momentarily causes atoms of the two gases to form excited molecules of xenon chloride, called excimers. The excimers quickly break apart, releasing photons that form an intense beam of ultraviolet light. The beam passes through a chamber filled with lead vapor; the vapor absorbs the ultraviolet light and shifts its wavelength to 459 nanometers. This corresponds to a deep-blue color.

The blue beam cuts through the water, striking a receiver aboard the sub. Inside a filter, cesium vapor absorbs photons at the specific wavelength of the laser, then re-emits this energy as photons with near-infrared wavelengths. A photodetector watches for these photons, which could not have penetrated from the surface. Radio signals sent up to the satellite convey information by modulating the laser photon stream.

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it possible for subs to stay hidden from enemy detection even longer. In addition, a torpedo-like receiver dubbed RAGU, deployed by sub, has been proposed to relay messages from satellites, eliminating the problems associated with receiving radio signals from aircraft. More about that later.

Submarines spend most of their time at great depths, moving slowly. That way, they emit very little noise while they listen—with sensitive sonar—for other subs [PS, July '83, July '85].

A sub never transmits while it is underway because that would reveal its position. But it must be able to receive incoming radio traffic. Much of this is purely routine: WHEN YOU GET TO POINT B, LOAD 500 POUNDS OF POTATOES AND 50 QUARTS OF OIL. From time to time, subs get more important signals —orders to move to designated locations, or to patrol in a different part of the sea. The new communications techniques are essential for these transmissions.

Supersensitive receiver

The blue laser being developed at Northrop Corp.'s Electronics Division in Hawthorne, Calif., is highly secret. The same is true of the blue-laser satellite, called SLCSAT (Submarine Laser Communications Satellite), which is under development at Lockheed Missiles & Space Co. in Sunnyvale, Calif. The Navy fears that if the blue-laser system is not closely guarded, the Soviets may learn the SLCSAT codes. Then they might be able to send false messages to U.S. submarines.

Still, several Pentagon officials have described the new laser in "sanitized" statements distilled from testimony given at secret hearings before Congressional committees. According to Robert Cooper, director of the Defense Advanced Research Projects Agency, a new optical receiver has greatly advanced the laser's usefulness. The laser-beam detector, invented at the University of Arizona, is far more sensitive than its predecessors. It's like "a development in aviation going from a Piper Cub propeller plane to a jet airliner," Cooper declares.

The blue-laser system has evolved from an older proposal based on a longer-wavelength blue-green laser: A large ground-based laser would produce a powerful sea-colored beam, and an orbiting mirror would reflect the beam into the ocean. The original blue-green laser idea was problematic. The beam would spread out as it rose through the atmosphere, and the mirrors would be huge.

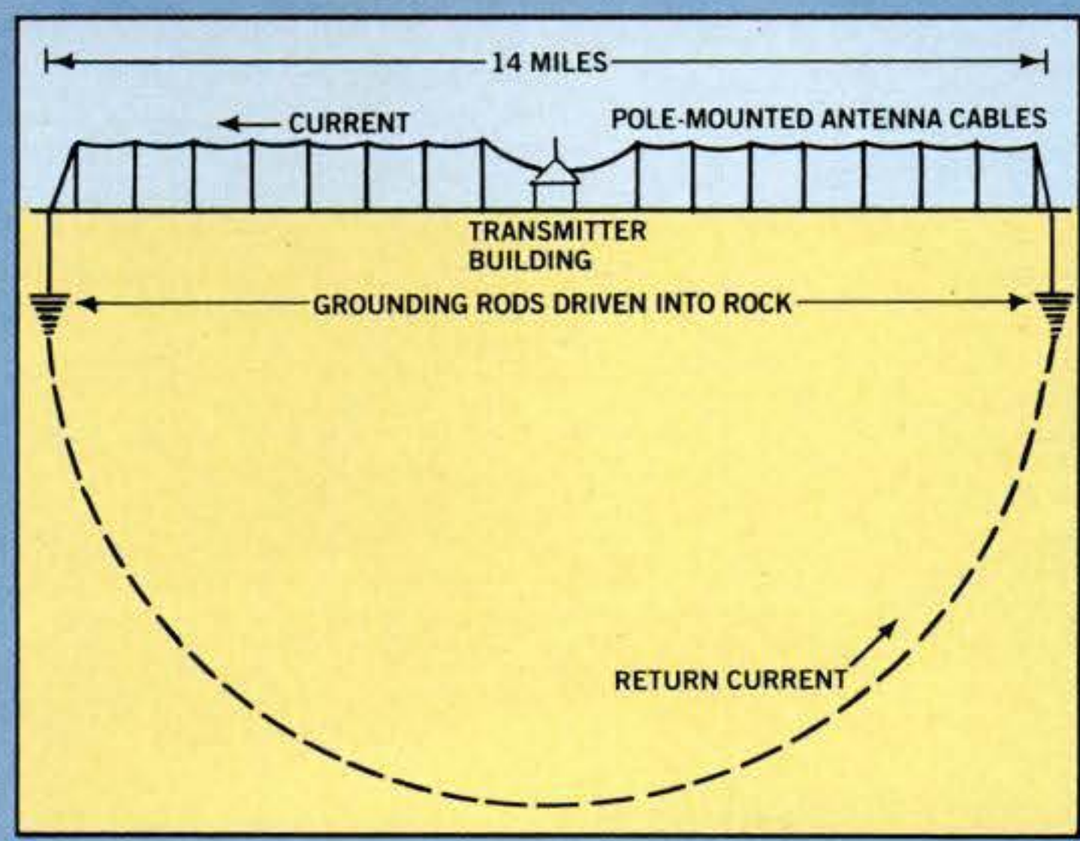
In the new blue-laser system, a radio receiver inside the satellite picks up messages and fires an on-board laser, so the beam comes directly from space. The supersensitive light detector aboard subs will enable satellite lasers with relatively modest outputs to do the job. But the gains, tests, show, would be impressive. Donald Latham, the Pentagon's chief of communications research, says the blue laser provides "a several-hundred-foot increase in the depth achievable."

Here's how a recent field test of the blue-laser system progressed:

It's a clear, bright day off San Clemente, Calif. The submarine *U.S.S. Dolphin* lies beneath the Pacific. Overhead, scarcely visible from the ground, a Sabreliner business jet traces its contrail through the sky, 20,000 to 30,000 feet up. A blue laser beam slants downward, shot from an 80-watt system aboard the aircraft. The beam cuts through the sea and reaches the *Dolphin,* transmitting messages.

"The depths we reached are astonishing—and classified," says a Pentagon official. Bigger lasers are coming. Already, Northrop has built a 400-watt blue laser called EXCEL, which will be able to penetrate hundreds of feet. Still, according to Cooper, the complete system won't be ready until the 1990s.

In the meantime, the Navy will rely on ELF radio transmitters nearing completion amid the forests of upper Michigan and northern Wisconsin. Although the blue laser is cloaked in secrecy, ELF is largely out in the open. To visit its sites, I flew to Marquette, Mich.



At the Wisconsin facility (above), a transmitter sends current through two 14-mile cables that form a giant X. The cables are insulated, and grounded at the ends. Current passes through bedrock to complete a circuit, generating electromagnetic waves in the Earth-ionosphere cavity (right). The antenna works best when the bedrock has very low conductivity and the current flows deep underground. ELF uses over a million watts of power, most of which dissipates in the earth. Only about 2 W go out in the signal. The monthly electric bill is $45,000.

DRAWINGS BY ELIOT BERGMAN

Shield rock

"The antennas consist of long cables like those of a power line, running for miles on telephone-like poles," explains Wiley Cress, the naval lieutenant showing me around. The transmitter's 56 miles of stiff braided-wire cable form a huge, ragged letter F on a map. (The shape is based on land availability and has no special significance.) The circuit is completed by the area's bedrock, a dry granite that is part of a formation known as the Laurentian Shield. The Navy chose this site because the rock, which has very low conductivity, forces the current to travel in a deep underground loop (see drawings).

Cress and I drive to K.I. Sawyer Air Force Base nearby, where the ELF control room is located. Radioman 2nd Class Mark Marshman, dressed in naval uniform, greets us. "SUBLANT, the submarine-control center in Norfolk, Va., controls the signal traffic," he states. "They will never let you inside the message center at Norfolk,

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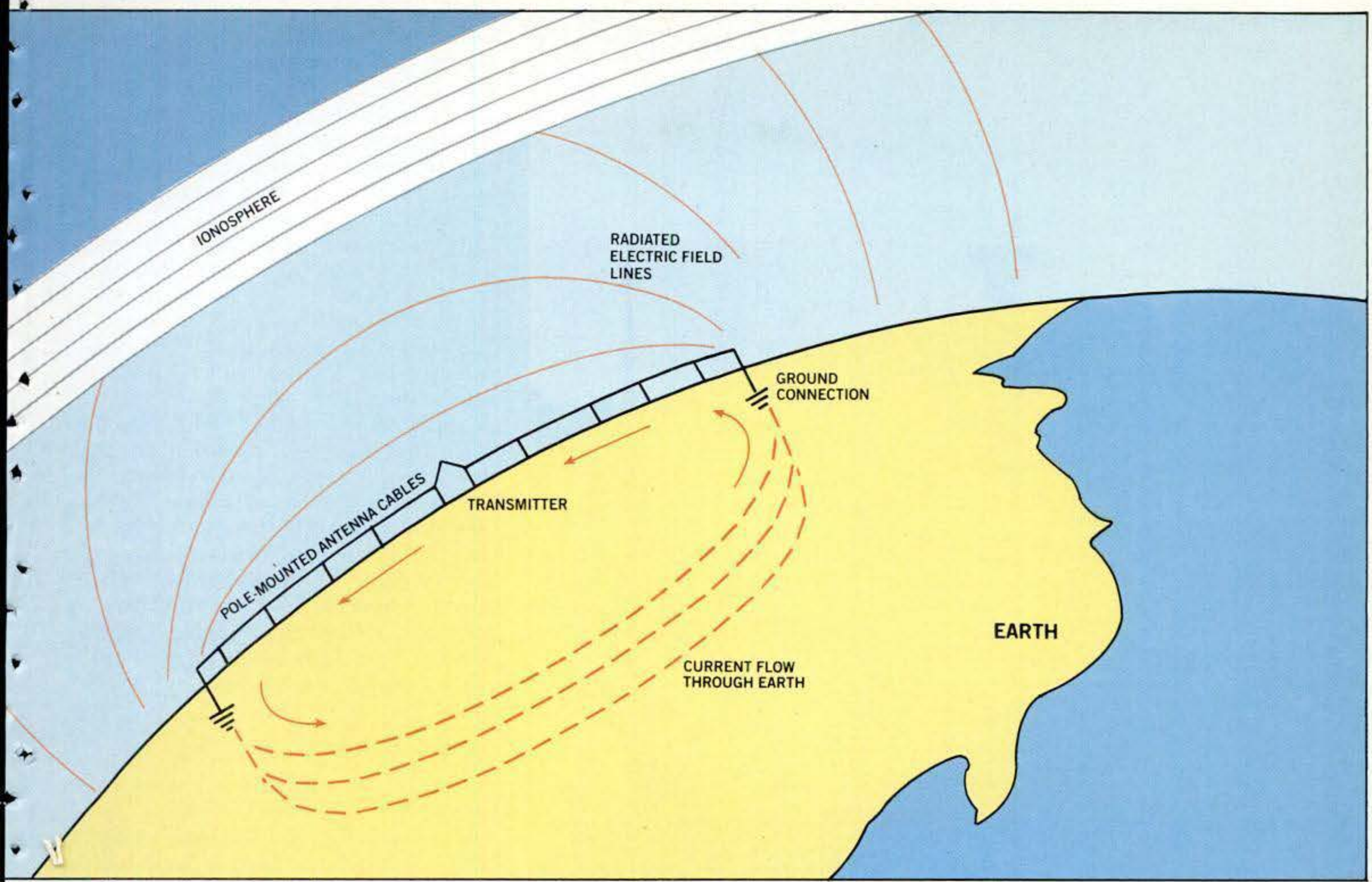

but what we have is nearly the same."

Marshman demonstrates the signaling procedure: "We receive teletype messages from SUBLANT, or orders over an encrypted telephone: SEND SUCH-AND-SUCH A MESSAGE FOR TWO HOURS." As he types on a keyboard, the console makes a mechanical clacking sound. "I'm sending a message that this is a training exercise. We don't have the code book. There's no coded message we could send that would order, 'Launch your missiles.' The orders are more like, 'Come up to receive further messages.' "

ELF can also direct course changes. For example, a carrier battle group might be in the Norwegian Sea, close to the Soviet Union. An attack sub rides out ahead, listening for Soviet subs armed with cruise missiles. A storm comes up, and the carrier force changes course. In the old days, the U.S. sub would blithely continue on its path. "I've been in exercises like this, and it's very frustrating," Cress recalls. "The sub could be three hundred miles away by the time he gets the word." But with ELF, the orders can reach the sub in a timely fashion.

Because the Michigan site is not yet operational, the next day Cress and I visit the Wisconsin facility to see a superpowerful transmitter working. The road leads through several small mining towns. I recall that ELF was the center of considerable controversy for a time: Protesting demonstrators sought to shut it down; environmentalists charged that it would create dangerous radiation; and state governors took the Navy to court [PS, Sept. '69].

Deep in the woods, we turn off on a logging road. A cable strung from wooden poles soon appears overhead. The Wisconsin transmitter features 28 miles of line, set in the shape of an enormous letter X.

Inside the transmitter station is a control room somewhat like that at Sawyer AFB. A row of seven security monitors shows scenes outside the fence. Digital counters flash bright-orange data: CURRENT, 297 AMPS; VOLTAGE, 6,300 VOLTS; FREQUENCY, 76.5 HERTZ. "We're sending the idle message, BCJ," the operator says. BCJ means the system is operating normally but says nothing more.

We walk into a large room with a concrete floor and a number of large gray cabinets. Cress opens the door to the transmitter cabinet, disclosing green circuit boards and blinking green and red lights. There is a loud hum, shifting between higher and lower pitches. "That's the coded signal," remarks Cress. "It takes five minutes to send the message once." Because the effective transmission power is so low after the radio waves dissipate in the earth, a sub must listen with care.

Flying messengers

Still, within the Navy, ELF can only convey prearranged messages that are listed in the commander's code book. Longer messages are delivered via the TACAMO radio system. TACAMO uses aircraft—modified C-130 transports—that fly in random patterns. When it is time to send a message to the subs, a winch whirs to life, reeling out a transmitting wire nearly five miles long, with a 90-pound weight at the end. The plane banks sharply and flies in a tight circle—the aircraft and its dangling cable resembling an enormous lasso. Because the radio signals cannot reach the ocean depths, subs must use towed cables or buoys to receive messages from TACAMO.

"In the old days, a sub would be carrying out exercises at depth," says Cress. "To receive messages, it would have to come up to one-hundred-thirty-foot depth every twelve hours and stream a cable. This takes time and interferes with normal operations. The sub has to clear its baffles, to start." The baffles are the region behind a sub where its on-board sonar cannot

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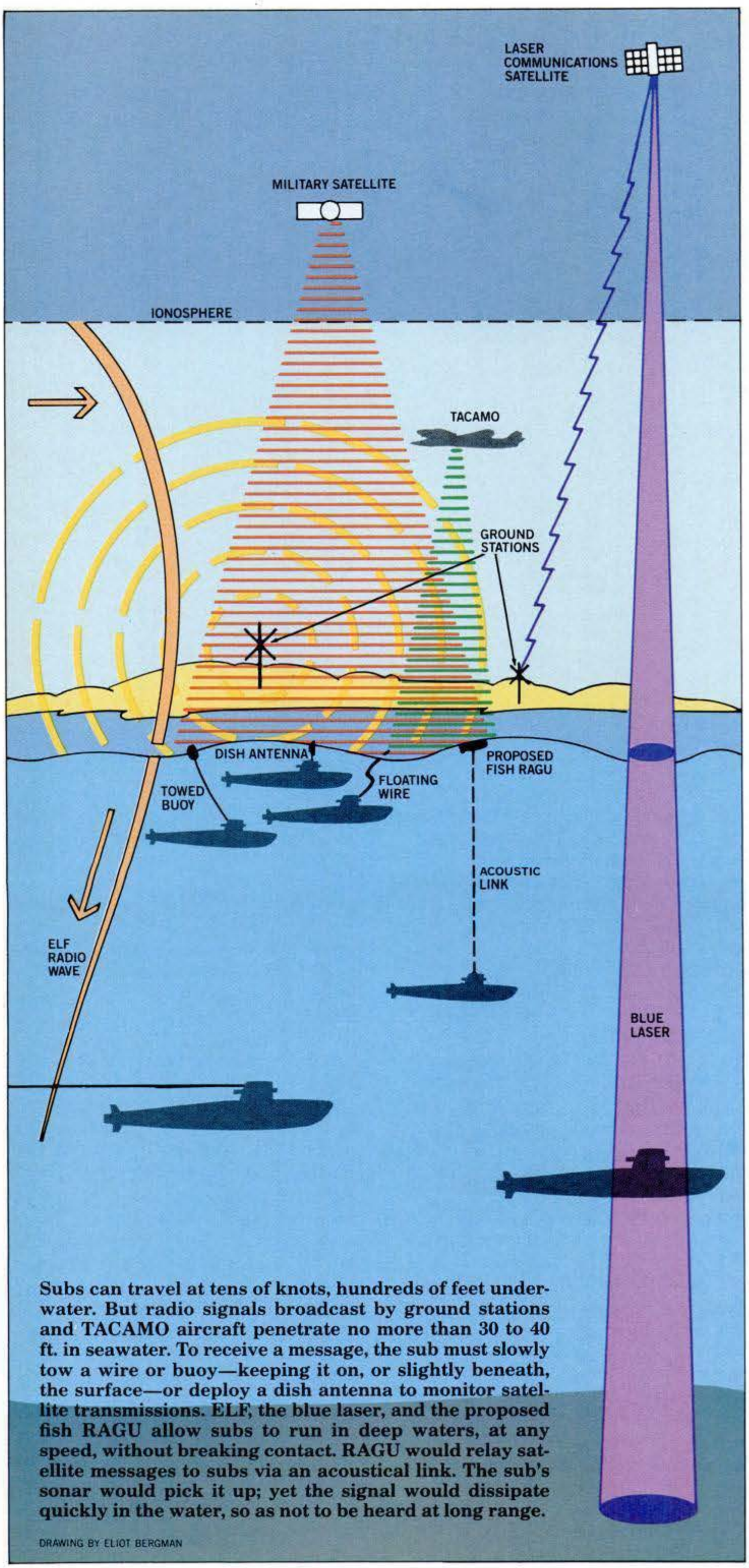

Subs can travel at tens of knots, hundreds of feet underwater. But radio signals broadcast by ground stations and TACAMO aircraft penetrate no more than 30 to 40 ft. in seawater. To receive a message, the sub must slowly tow a wire or buoy—keeping it on, or slightly beneath, the surface—or deploy a dish antenna to monitor satellite transmissions. ELF, the blue laser, and the proposed fish RAGU allow subs to run in deep waters, at any speed, without breaking contact. RAGU would relay satellite messages to subs via an acoustical link. The sub's sonar would pick it up; yet the signal would dissipate quickly in the water, so as not to be heard at long range.

DRAWING BY ELIOT BERGMAN

hear the sound of a ship. "You could have a carrier going with all four screws, and you'd never hear him, so you turn to the left and right to hear what's behind you. Then you come up to periscope depth and look around. Plus, your sub has no keel. In a storm, it's like a hot dog being tossed about in a whirlpool bath."

At this moment, a TACAMO aircraft is in flight somewhere over the Pacific, and another one is above the Atlantic. This system is being upgraded. The aging C-130s will be replaced with modified Boeing 707 jets. But to receive the signals, subs will still have to approach the surface and deploy a cable that serves as an antenna, or tow a buoy—hoping it stays beneath the surface where it will not be seen (see drawing). Sometimes this isn't easy. IBM's Richard Garwin, a longtime inventor of naval systems, knows what can happen. Says Garwin: "Skippers at periscope depth have looked out and seen birds perching on their cables." And buoys, he adds, are hard to handle.

Satellite link

Instead, Garwin proposes what he calls a "fish RAGU." (RAGU stands for Radio Receiving and Generally Useful.) It would be a small torpedo-like device, battery powered and able to swim a few feet below the surface. It would proceed at only a few knots, but subs rarely go faster, because at higher speeds they make more noise and are more easily detected. As Garwin describes it, "You could send the fish a signal by radio: 'Precisely one minute from now a burst of satellite communications will come.' The fish would stop, put up a little antenna that would point to the satellite's location for a second or so, and receive a million bits of information." The fish would then retransmit these messages using a sonar-like acoustic signal, a high-frequency sound directed at the sub.

These systems—the blue laser in the 1990s, ELF today, TACAMO and its upgraded aircraft soon, and the fish RAGU if it should be needed—will make it easier for subs to hide from enemies. Adm. James Watkins, the chief of naval operations, describes the payoff with the help of a story by Mark Twain: "Two bulldogs met. They circled, snarling and growling. Both were bluffing, so nothing happened. And they were about to walk off when one of them opened his mouth. He had no teeth. So the other dog tore him to pieces." In Watkins's view, improved communications are an important way for submarine forces to sharpen their teeth. PS

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Engineering tomorrow's airliners

With the exception of scimitar-shaped propeller blades on rear-mounted engines, the next generation of commercial airliners won't look that different than today's big transports. On the inside, however, advanced electronic, structural, avionic, and aerodynamic systems—as well as innovative interiors—will make the new airplanes safer, cheaper to operate, more flexible in seating, and—for those of us in the back of the bus—more comfortable than ever before.

By JIM SCHEFTER
Drawing by Dan Osyczka

The voice is clear, but the tone is more like a drill sergeant's bark: "Display... ground speed!"

A flat-panel video screen, centered in the captain's console just to the right of his pistol-grip controller stick, flickers briefly. Then the information he demanded appears in vivid green characters, sandwiched between multicolored navigation graphics: G/S 461 NM/H [nautical miles per hour].

Leaning forward, the captain types the new data into a terminal on the desklike shelf just above his lap, then reads the fresh calculations from the airplane's master computer that appear on its eight-line screen. The flight is two minutes ahead of schedule.

The captain punches new commands into the computer. Signals flash along lengthy fiber-optic bundles to the twin prop-fan engines flanking the ship's stubby T-tail. Passengers in the rear cabin hear a slight change in pitch from the engines' dual eight-blade propeller banks, but they hardly feel the automatic trim adjustment that keeps the aircraft level.

Back on the flight deck—some call it the "glass cockpit"—the digital ground-speed reading drops to 455 nm/h. This flight will keep its appointment over the next checkpoint with a margin of only seconds.

Already the race is on between Boeing Commercial Airplane Co. (Seattle, Wash.) and Douglas Aircraft Co. (Long Beach, Calif.), in concert with various aircraft-engine builders, to produce an airplane that will operate along the lines just described. The final details on the airliner's size, shape, and interior layout are being sketched today on computerized design screens and drafting tables. Assisting are experts at the National Aeronautics and Space Administration (NASA), who are using the world's most advanced flight-deck simulators and are testing high-speed propellers in the air. You should be flying in the new planes in the early 1990s.

"At first, we were looking at a new aircraft for 1989," says John A. Bates, customer requirements manager for the new Boeing 7J7. "But we realized that new technologies now being perfected would make a 1992 airplane much more competitive. The extra three years will make it forty-five to fifty percent more efficient in seat-miles per gallon."

Douglas Aircraft designers have reached the same conclusions, and the technological changes they envision are dramatic:

Tomorrow's airliner will be powered by new-technology prop-fan engines [PS, March '85], flown by two-person crews from a flight deck that looks more like an electronic office than a cockpit, and may be stabilized in flight by computers using fly-by-wire and fly-by-light controls that replace mechanical linkages. Advanced composite materials and new aluminum-lithium alloys will be used in many structural components to reduce weight and make manufacturing easier. Laminar-flow wings, which have strategically placed channels that suck in drag-causing turbulent air, may also be included to improve aerodynamic efficiency.

Perhaps most significant to the airline companies is that the planes will use up to 50 percent less fuel while flying about as fast as today's jets. Computer-synthesized voice alarms will alert the pilots to in-flight problems. And if NASA researchers perfect a voice-recognition system in the Advanced Concepts Flight Station Simulator at Ames Research Center (Mountain View, Calif.), the pilots will be able to call up some displays simply by asking for them.

Despite certain refinements and improvements in comfort, such as wider seats and aisles as well as seat-back video screens (see drawing), tomorrow's passenger will be hard-pressed to tell the difference between today's jets and a propeller-driven Boeing 7J7 or McDonnell Douglas MD-94. But to airline executives, the cabin interiors will provide unheard-of seating flexibility, being able to easily convert, for instance, from mostly economy-class seating to mostly first-class overnight.

The biggest and most obvious design change is the return to propellers. Both Boeing and Douglas are committed to advanced prop-fan (or unducted fan) technology—they prefer the term "ultra-high bypass" engine—which uses wide-chord external propellers powered by turbojet engines. Both General Electric Co. and the combine of General Motors Allison Div./Pratt & Whitney Aircraft Group, United Technologies Corp. expect to complete development on prop-fan engines and blades by 1990. (Rolls Royce Ltd., in England, which is also developing similar

[Continued on page 52]

"The package of technological advances that we could incorporate into a new airplane around 1992 is the greatest since we brought out the 707 in 1958," says one Boeing executive. And the list of possible improvements that could be incorporated in tomorrow's airliner is extensive.

First and foremost are advanced prop-fan engines that move a far larger volume of air per unit of aviation fuel than today's conventional turbofans. General Electric's ultra-high-bypass engine (lower right) has no gearbox, which many engine designers consider a maintenance problem.

The wings themselves will have many refinements that will improve their aerodynamic efficiency. High-aspect-ratio wings—large spans, slender planforms—provide high cruising efficiency. Specially shaped supercritical airfoils—flattened on top, bulging on the bottom—decrease drag and provide greater room for fuel. Winglets, vertical wing-tip blades, smooth out drag-producing vortices that normally follow the tips. Laminar flow control (lower center), which may be used in some form, has special holes or slots in the wing's surface, which suck in drag-causing eddies that form at the boundary layer. Computerized stability augmentation involves using a smaller tail, thus trading some static aerodynamic stability for decreased drag. The computers monitor the airplane's stability and automatically (without

The next generation airliner— three dozen ways it'll be better

NASA/AMES ADVANCED-CONCEPTS FLIGHT SIMULATOR

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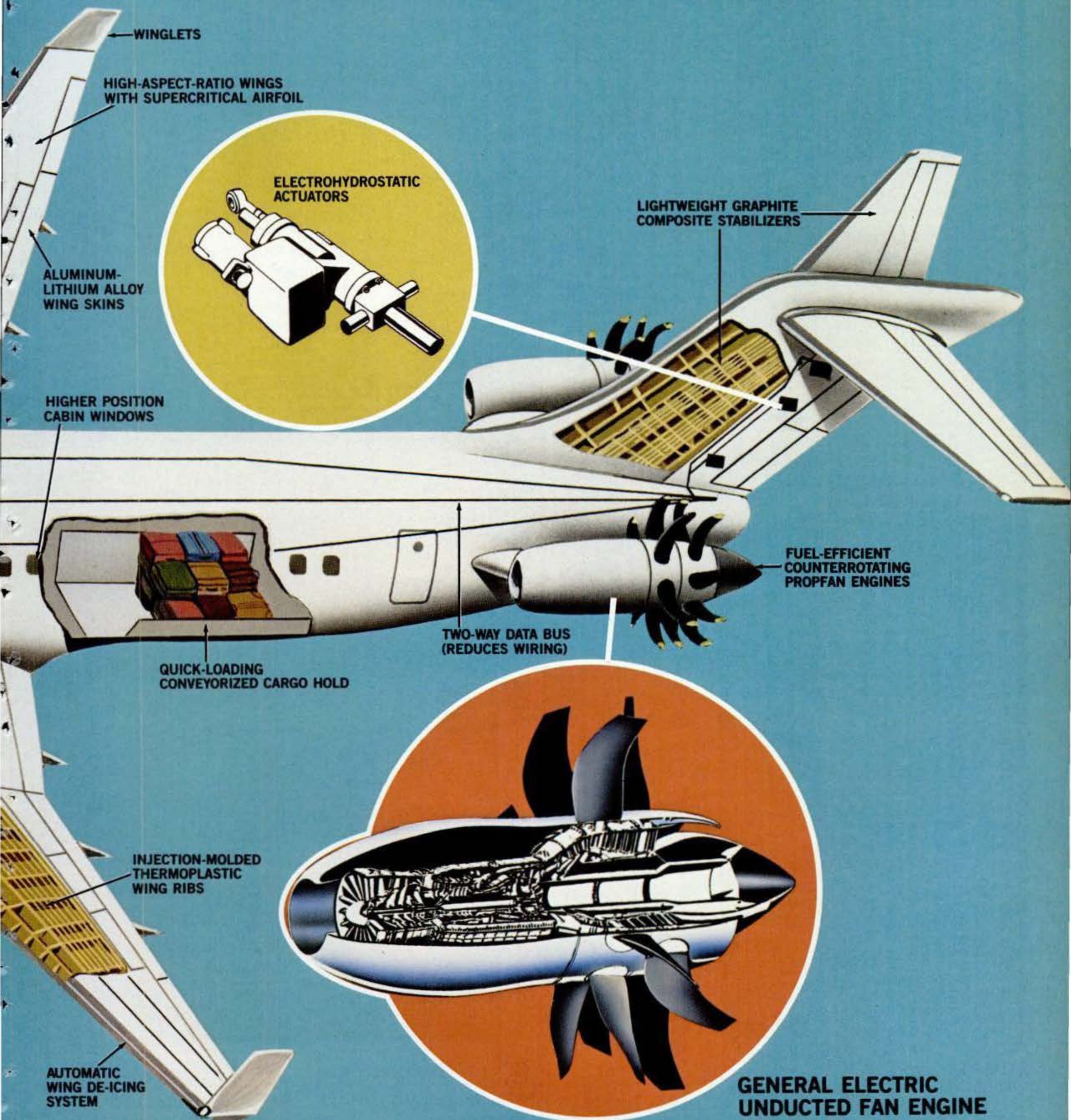
the pilot's input) compensate with small control surface movements. Riblets, thin grooves in the skin, also cut drag.

Besides being more roomy, the flight deck will incorporate several systems that will make flying safer and easier. These may include expert pilot-assistance computer systems and voice-actuated displays. The global positioning system will use signals from navigation satellites to pinpoint the airliner's position on the map. On approach to the runway, the airplane will ride down a microwave beam sent out by the airport. The traffic-avoidance system will alert the pilot (independently of the ground-based traffic-control system) when another plane comes into dangerously close proximity. And the Doppler radar system will locate unseen but dangerous microbursts (wind shear) in the vicinity of the flight [PS, March].

Fly-by-wire and fly-by-light control systems will reduce weight by eliminating control surface cables and pulleys. Electrohydrostatic actuators will make the heavy hydraulic plumbing networks unnecessary.

The passenger cabin will also be larger and more comfortable. Quick-change seat-pitch capability will allow unneeded seats to be compressed, permitting more space for the passengers. Flat-panel video screens on each seat-back means that everyone will finally be able to see the movie.



GENERAL ELECTRIC UNDUCTED FAN ENGINE

prop-fan designs, is said to be somewhat behind the other companies at this time.) The blades themselves are swept back into flowing, compound curves like those on a ship's screw. Developed during more than a decade of NASA-sponsored research, the propellers remain effective at speeds of Mach 0.8 or more. Earlier propellers lost efficiency above Mach 0.6.

A basic question to be resolved concerning prop-fan engines centers on the noise they produce. During NASA's first public ground test of its advanced prop-fan engine at the Rohr Corp.'s test facility near San Diego, Calif., last June, I watched the Hamilton-Standard blades start to turn as the high-pitched whine of the Allison turbine pierced the air. In moments, the eight curved blades —looking like a low-amplitude sine wave when seen edge-on—dissolved into a gray blur. Then came a growing hum, like a giant buzz saw about to chew into a log—it was the sound of the prop-fan, its growl overlaying the turbine's scream. From about 150 feet away, it wasn't unpleasant. But it certainly was different. The thought of sitting in one of Boeing's or Douglas's flying tubes for several hours listening to that sound was something else, however. It was obvious that cabin noise will be a far more important problem than so-called "community noise," the sound you hear on the side of the runway when a plane takes off or lands.

The NASA engine, a tractor (or puller) type, was scheduled to begin flight tests early in 1987, mounted on the left wing of a modified Gulfstream-II business jet. As part of those tests, Lockheed Corp. engineers will analyze the noise it emits, looking for the right combination of insulation and sound-deadening materials to keep airline passengers happy.

"The potential saving for the airlines is more than two-and-a-half billion gallons a year," says Keith Seiver, director of the advanced turboprop program at NASA's Lewis Research Center (Cleveland, Ohio). "But it doesn't matter how much fuel we save if passengers won't accept it."

One way to reduce cabin noise is to put prop-fan engines behind the passenger cabin. Boeing and Douglas plan to use pusher configurations, with twin engines mounted near the tail. Both companies have their own flight-test programs underway using General Electric Co.'s unducted fan to gather data on in-flight performance and noise levels.

Boeing was first into the air (see photograph), beginning tests late last summer with a GE engine featuring two counterrotating banks of eight propellers, each mounted on a modified 727. Engineers now are evaluating the data they collected as part of the preliminary 7J7 design. Douglas will begin flying a second version of the GE engine, this one with counterrotating banks of eight and 10 blades, respectively, mounted on a modified MD-80 in early June.

"Putting these high-speed propellers on an airplane isn't easy," explains John Morris, director of advanced engineering for Douglas in Long Beach. "The blades have transonic tip speeds and produce a lot of noise at cruise speeds. We have to keep the noise down and make sure that the adjacent structure can survive 75,000 hours of flight without induced damage from sonic fatigue.

"The configuration we're all coming up with is the aft-mount, counterrotating pusher. But none of us has any experience in designing that kind of aircraft."

They're getting the on-the-job experience now. Douglas will probably be first with a prop-fan aircraft—not all-new, but derived from the company's popular MD-80 family. That's one of the few airliners in production today that could be fitted with prop-fan engines. To be called the MD-91, the first is scheduled for delivery in late-1991.

"The key issue is the engines," Morris says. "We have to make sure that there are no aerodynamic show-stoppers in the configuration." He expects Douglas engineers to complete their analysis, which includes wind-tunnel tests and upcoming flight tests, by the end of this year. "By then, we should know how to deal with all the problems and be able to commit to development of the MD-91," Morris says.

The MD-91 will have twin prop-fan engines mounted on pylons to keep the propeller clear of the rear fuselage. Its wing tips will be sharper and angled slightly to the rear for improved aerodynamics, and its glass cockpit will incorporate the latest in electronic instrumentation and controls.

By 1994, Douglas hopes to deliver an all-new prop-fan airliner, the MD-94. Its preliminary design shows a 180-seat craft with twin engines at the rear and a T-tail. "We don't have to commit to that aircraft until 1990," Morris says. "But it will have all the technology that it makes sense to include. We're looking at composites

[Continued on page 98]

A prototype prop-fan engine built by General Electric Co. made its maiden flight last August mounted on the stern of a modified Boeing 727. The unducted fan is expected to provide more than 30% greater fuel efficiency than turbofans.

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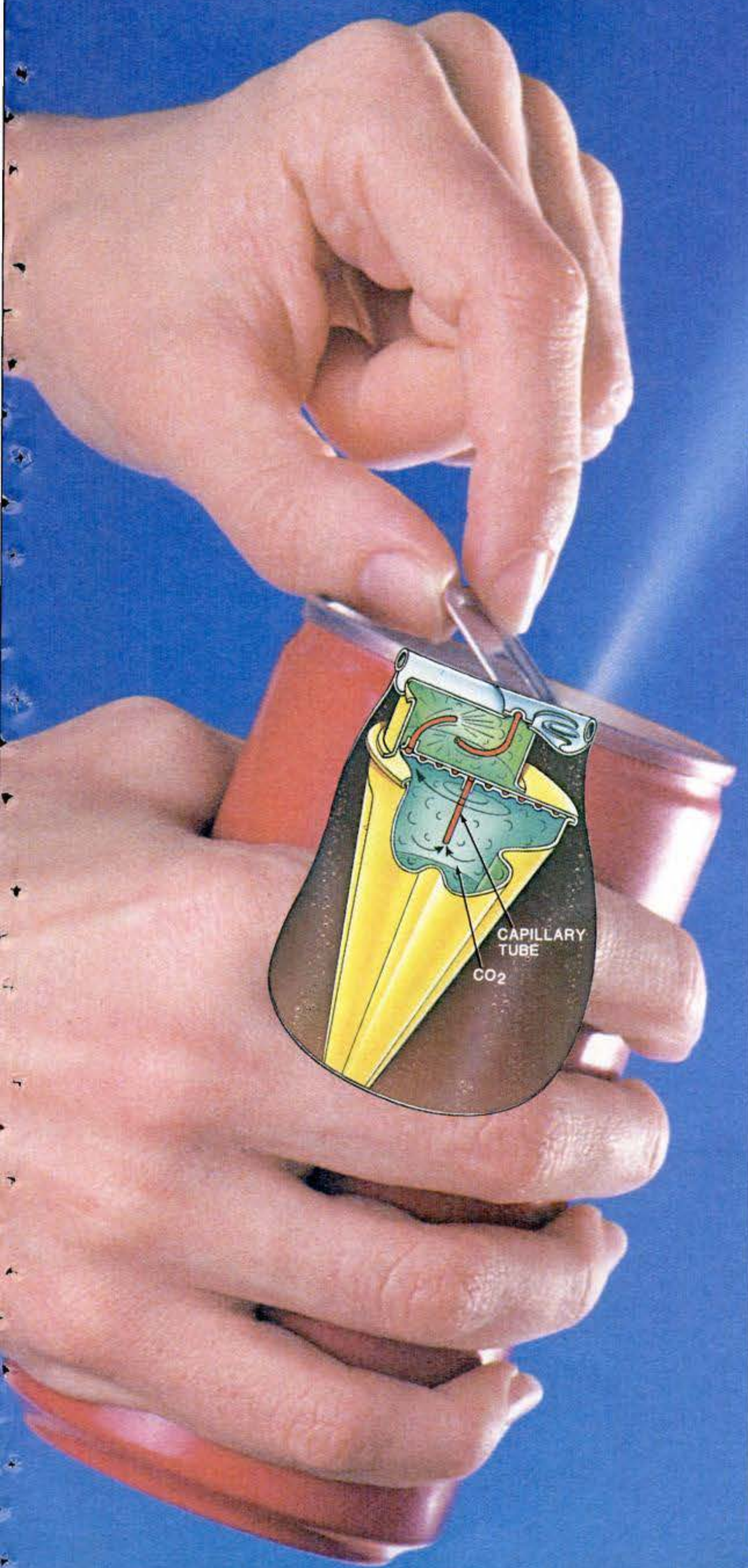
Self-cooling cans

A reservoir filled with liquid carbon dioxide may make ice cubes, picnic chests, and refrigerated vending machines obsolete. It chills a canned beverage in a minute or two.



By GODE DAVIS
Photo by Jim Richards

A loud hiss greets me as I open an experimental self-chilling can. A carbon dioxide vapor trail appears for a few seconds, then vanishes. Inside a special chamber that releases the gas, the temperature plummets, settling at −60 degrees F after about 35 seconds. I insert a thermometer into the beverage, and the mercury slides down to a frosty 33 degrees F. Bending closer, I see a few ice crystals floating in the drink.

I'm at the Holcomb family's tiny lab in rural Marion County, Ala. Robert R. Holcomb, a physician, is the inventor of a CO_2-filled cooling unit that, once activated, chills itself, then soda or beer it's immersed in. The device could eliminate the need for ice or refrigeration. That makes it a potentially hot item in the beverage industry, which sells one billion cans a day.

Holcomb's idea came from Jim Dooley, an Arkansas man. An Army cook during the Vietnam War, Dooley cooled beers for a general by hosing them down with a CO_2 fire extinguisher. He realized that as CO_2 becomes gaseous and expands, it removes heat from its surroundings. In the new device, a scored capillary tube breaks when the can's tab is pulled (inset drawing). Gas escapes slowly through the spiraling tiny tube and has the maximum chilling effect. But the can won't over-cool, because ice forms on the cone-shaped CO_2 chamber and insulates it.

A key design and production problem, being negotiated with a manufacturer, is the high-pressure CO_2 chamber. "We could make fifty experimental chambers in our lab," says Holcomb, "but we couldn't mass-produce them." Nor has Superior Marketing Research Corp. (Salt Lake City, Utah), which has the patent rights, figured out how manufacturers will insert the device in cans before they are filled. Still, Superior estimates the cans will appear on supermarket shelves sometime next year. Customers might pay 10 to 15 cents extra for the cooling devices, which would displace up to two ounces of beverage. PS

DRAWING BY PAT RUGGERO

COLD FUSION

Hydrogen fusion at room temperature? The notion sounds absurd. But recent experiments show that a scheme for cold fusion may just be possible.

By ARTHUR FISHER
Drawings by Mitchell Albala

The hot word in fusion research today is cold, for cold fusion. If things break right in experiments being conducted by Steven E. Jones of Brigham Young University—and that's a very big if—it could turn out to be the answer to an energy prayer.

To understand why, a little background is necessary. For more than three decades, physicists have relentlessly pursued the goal of controlled thermonuclear fusion. In a world of rapidly diminishing fossil fuels, an energy source that is both renewable and essentially non-polluting is worth maximum effort. The fuel for fusion is available in seawater, and its end product, besides energy, is harmless helium.

But the long haul to develop controlled thermonuclear fusion (as opposed to the unleashed violence of an H-bomb) has been frustrating. Many milestones have been passed, but real success always seems to be 20 years in the future. Some experts question, because of the enormous engineering and technical problems that still remain, whether energy from thermonuclear fusion will ever be economically viable.

Confinement and temperature

The problems with thermonuclear fusion stem from the nature of the fusion process itself. Two heavy hydrogen ions fuse to form a helium nucleus; the mass of the end product is slightly smaller than the combined masses of the hydrogen ions; and that extra mass is converted into prodigious energy. But both ions are positively charged, and therefore repel one another. For fusion to occur, something must overcome this electrostatic repulsion, squeezing the ions close enough together for the strong nuclear force (which is attractive and operates over a very short range) to take over. Moreover, the particles have to be confined long enough and at a high enough density for fusion to be self-sustaining, a combination called the Lawson criteria.

In the sun's core, the temperature is 10 million degrees, and particles are confined by gravitational pressure due to the sun's enormous mass. On Earth, a temperature of 100 million degrees is needed for the most favorable reaction, fusing deuterium and tritium, the two heavy isotopes of hydrogen. (One ounce of hydrogen consumed this way yields the energy equivalent of burning 78,000 gallons of gasoline.)

Two avenues of confinement have been pursued. One is using magnetic lines of force to contain a hot plasma, akin, in the well-worn phrase, to trapping Jell-O with rubber bands. The other is called inertial confinement, in which a fuel pellet is zapped with a laser or ion beam of such intensity that the ingredients don't get a chance to disperse. Both approaches have been plagued with difficulties.

There is, however, another way to induce fusion. Called muon-catalyzed fusion, or mcf, it depends on an obscure effect that was first theorized by F. C. Frank of the University of Bristol in 1947, and further explored by Andrei Sakharov and other Russian physicists shortly thereafter. Their idea was that the muon could serve as a catalyst for fusion, allowing the hydrogen ions to fuse at low temperatures—even as low as room temperature—and emerge from the reaction unscathed, so that it could recycle. The muon is a subatomic particle that had been discovered just 10 years earlier.

In 1956, the effect was actually seen by Nobelist Luis Alvarez at the University of California, Berkeley, when muons stopped inside a bubble chamber filled with liquid hydrogen and deuterium. "We had a short but exhilarating experience," Alvarez recalled later, "when we thought we had solved all the fuel problems of mankind for the rest of time." With the help of Edward Teller, the Berkeley group figured out the mechanics of the reaction, in which the muon forms a molecule containing the fusion particles. Because of the muon's great mass, its orbit is much tighter than an ordinary electron's would be, and it binds the particles some 200 times more closely together than in an ordinary heavy hydrogen molecule. This muonic confinement creates conditions inside the molecule similar to those inside a white dwarf star, even though the rest of the gas may be at room temperature, and fusion occurs in about a trillionth of a second.

The initial excitement subsided rapidly when calculations showed that because the muon had a lifetime of a mere two microseconds, 15 times shorter than the time it took to form the muonic molecule, any given muon could catalyze no more than one or two fusions. It takes lots of energy to make a muon in an accelerator, so just to break even would require 300 to 400 fusions per muon.

Resonance to the rescue

For two decades the concept lay dormant, a scientific curiosity. Then in 1977, two Soviet theoreticians predicted a feature called resonance if deuterium and tritium were used. It meant that the muonic molecule would actually form in 10 nanoseconds rather than 30 microseconds, allowing perhaps 110 fusions per muon.

Intrigued by this work, Steven E. Jones, then at Idaho National Engineering Laboratory, decided to test the predictions. In 1982 he and his group began a series of experiments, with funding from the Department of Energy, using the muon beam at the Los Alamos Meson Physics Facility with the participation of Mel Leon and other physicists there. (The project is now a collaboration among Brigham Young University, Los Alamos National Laboratory, and Idaho National Engineering Laboratory.)

To contain the deuterium-tritium mixture, the team designed target capsules with a 3½-inch-diameter pressure vessel, a stainless-steel chamber whose interior was gold-plated. "I had a little trouble carrying this thing the first

[Continued on page 100]

MUONIC ATOM FORMATION

$t\mu$

$d\mu$

FREE MUON

μ^-

d

$dt\mu$

MUONIC MOLECULE FORMATION

DECAY

$\alpha\mu$

STICKING

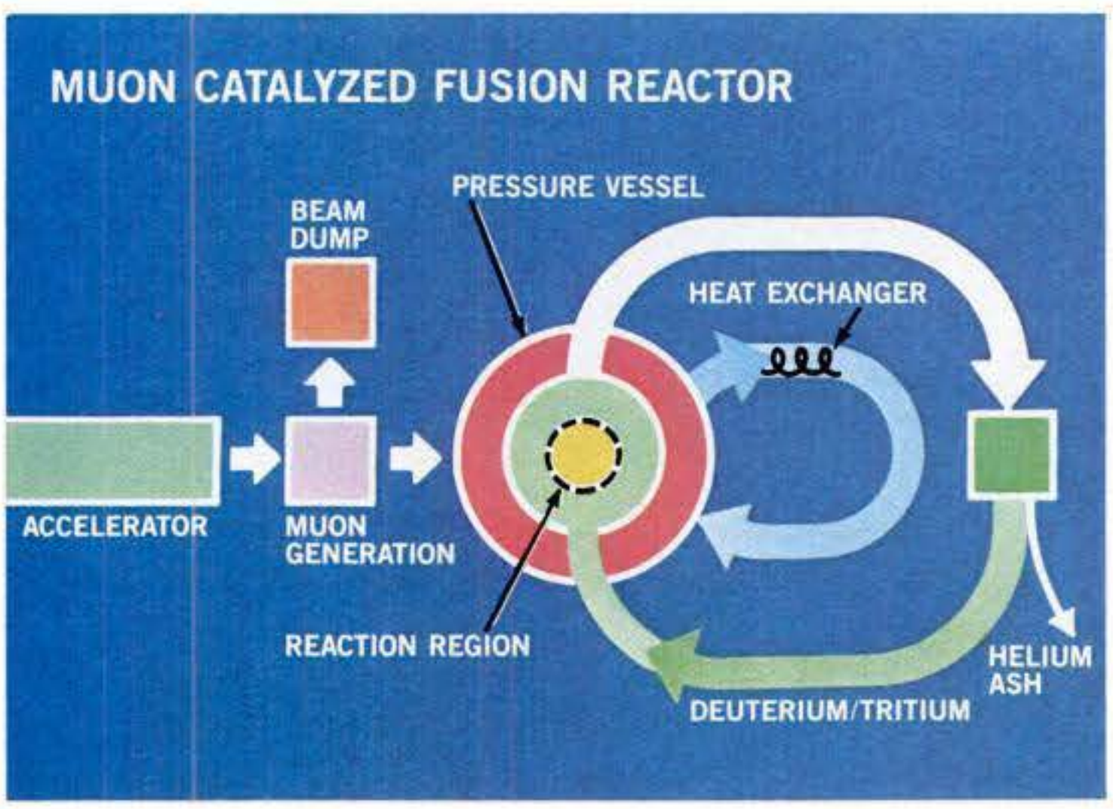
99 + %

α

μ

n

FUSION



Muon-catalyzed fusion reaction (above) starts with a negative muon entering a deuterium-tritium mixture. The muon quickly replaces an electron to form a muonic $d\mu$ or $t\mu$ atom. If the muon first forms a $d\mu$ atom, it will transfer to the heavier triton, with its greater binding energy. This atom then penetrates a deuterium or deuterium-tritium molecule and joins with a deuteron in a resonance process to form a $dt\mu$ molecular ion inside a complex muonic molecule. Here, a deuteron and a triton are bound 200 times more closely than normal. Fusion results, with the release of an energetic neutron, an alpha particle, and a muon, which is free to continue the cycle. In a small percentage of fusions, the muon sticks to the alpha particle. In a simple reactor concept (left), an accelerator generates muons (the rest of the beam is dumped); heat energy is drawn via an exchanger; and non-polluting helium residues are collected.

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Super still

A big blue machine that holds stacks of metal heat-transfer plates may also hold an answer to water and fuel shortages. SuperStill can distill alcohol or extract pure water from polluted water. The process isn't new, but the still's creator found a way to recycle most of the energy normally lost converting liquid to steam.

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By MICHAEL BOWKER
Photos by Peter Nuding

Inventor Stephan Sears plunges a hose into a bucket, drawing brackish swamp water into a rectangular suitcase-size distilling machine. The machine hums and gurgles like a small refrigerator with intestinal problems. Through a special clear housing I see the dark water boiling and bouncing inside like percolating coffee. Moments later, sparkling cool water streams out of the blue machine into a glass.

"Go ahead," says Sears, grinning at the dubious look on my face. "It's pure, delicious water." I drain my glass of distilled water and discover he's right.

Sears claims his invention, called a vapor compression water processor, has unique advantages over other purifiers: By recycling more than 98 percent of the heat energy it uses for evaporation, it needs far less energy to distill water—or even to produce fuel alcohol. Some 30 prototype and about 200 commercial processors, with different capacities, are being used by businesses and in a few homes. Because of its complexity, the machine demands more maintenance than other distillation hardware. Sears nevertheless envisions larger units being used for pollution control or supplying cities with pure water distilled from oceans.

Sears began developing the distiller in 1976 during one of California's worst droughts. "People were desperate for water," he recalls. "I wondered if there was a practical way to make drinking water from the ocean." He formed Superstill Technology, Inc. (888 Second Ave., Redwood City, Calif., 94063) to tackle the problem.

Sears, 44, had studied physics at Stanford University and the University of California at San Diego before becoming a consultant for Westinghouse and other companies. He had also helped develop the forerunner to the home VCR. When the drought struck, Sears had just completed work

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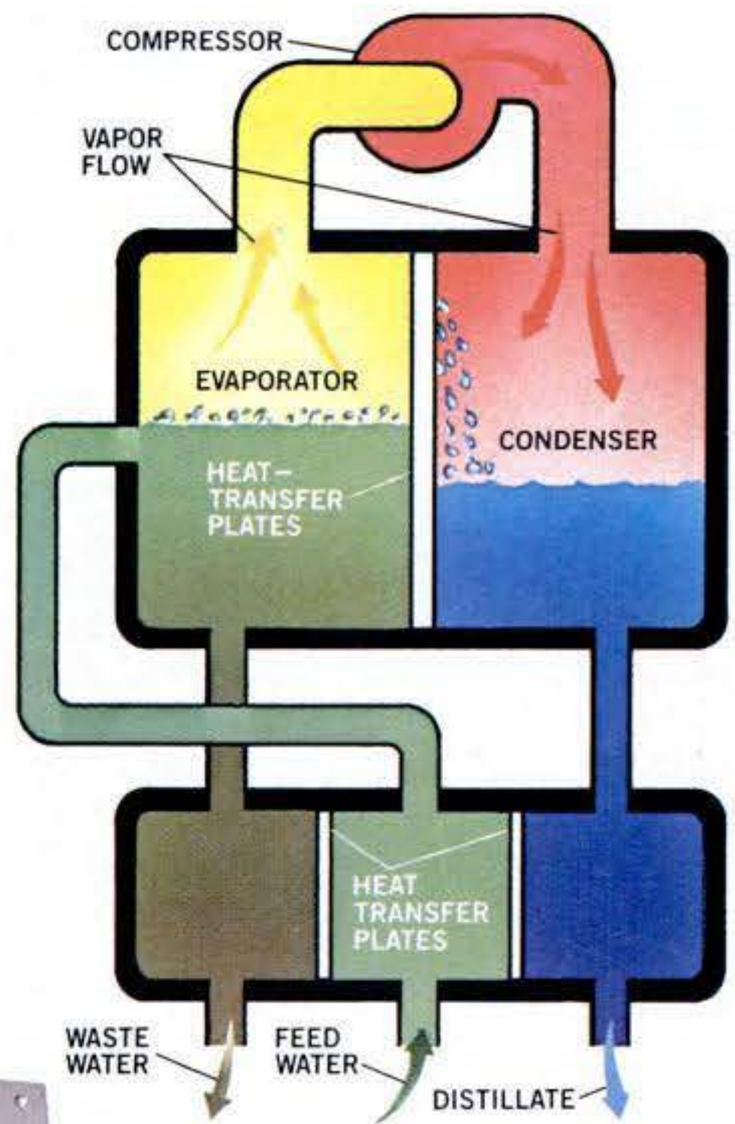
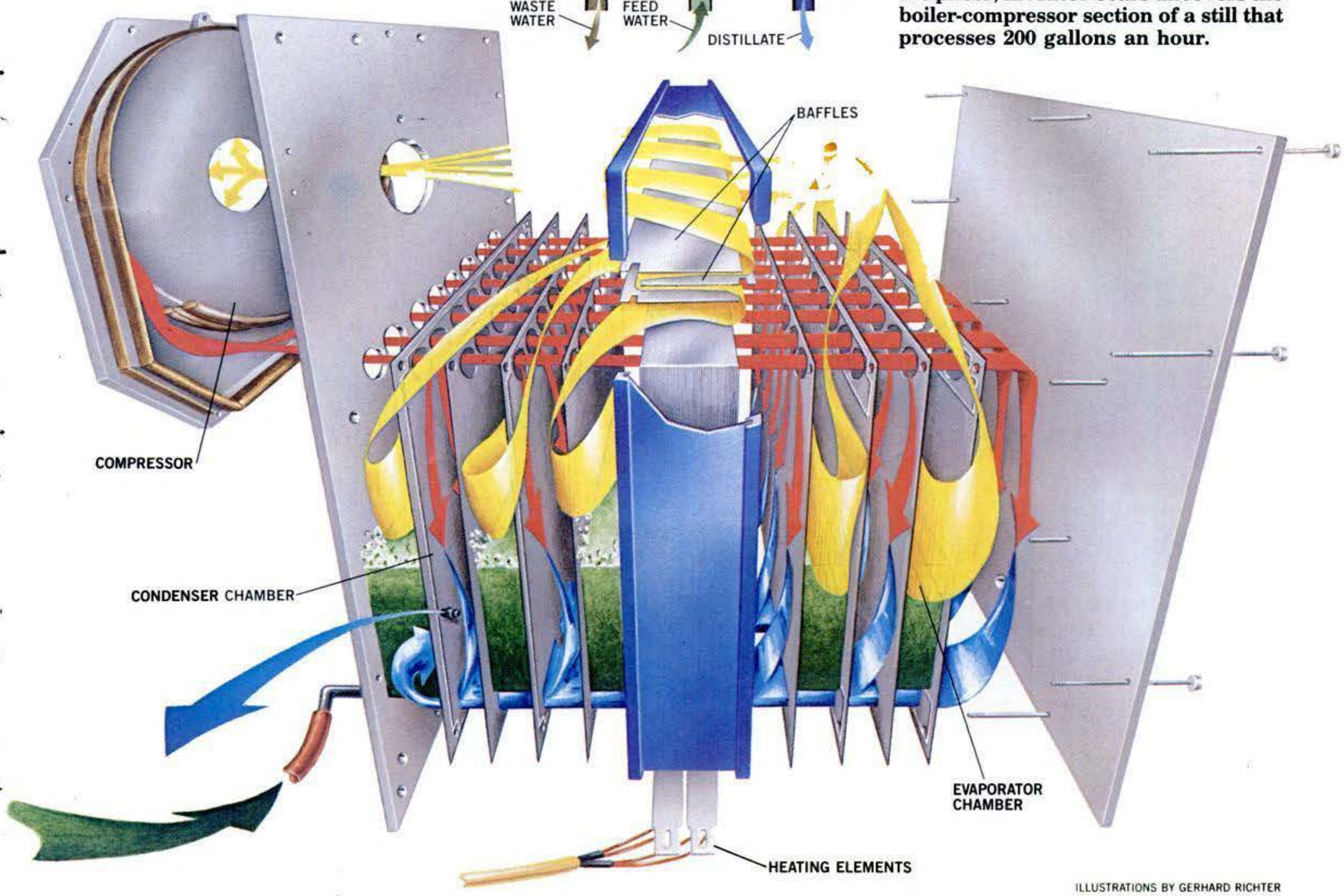


Feed water enters a heat exchanger (left) where it is warmed by outgoing distillate and waste water. Feed water is then degasified and fed into the evaporator-condenser core. The core, a section of which is detailed below, consists of stacked thin metal plates, separated by gaskets that form channels directing the liquid and vapor flows. Impure feed water (green) enters alternating evaporator sections, where it boils. Steam (yellow) exits through gasket openings, passes through baffles that remove mist, and is drawn into the compressor. Compressor pressurizes steam and sends it (red) into alternating condenser chambers via a manifold formed by the plate stack. Steam condenses and drips down as pure water (blue), then exits through another manifold. Unvaporized feed water containing dissolved solids is continuously discharged. After start-up, heating elements are used only intermittently. In the photo, inventor Sears uncovers the boiler-compressor section of a still that processes 200 gallons an hour.



ILLUSTRATIONS BY GERHARD RICHTER

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on an ink-jet printing process to which he holds worldwide patents leased by IBM and Canon. Using the patent profits, Sears funded his own research. He had only one employee and a small office, but by mid '82 he had built six 400-gallon-per-day prototypes.

Sears's machines use simple distillation principles. "If you have a bucket of seawater and want to turn it into fresh water, what do you do?" he asks, as we sit in his office amidst a clutter of physics books, exotic toy puzzles he develops, and stacks of curious, square stainless-steel plates. "You put heat into the water to boil it and add energy to convert the water to steam. The steam rises, leaving behind the salt and pollutants. Then you move the steam to another spot and condense it, and you have pure, fresh water.

"But that's the easy part. The hard part is figuring out how to do it cheaply." It took 20 different inventions—most of which have patents pending—along with more than 10 years of work and $2 million of his own money before Sears felt he had solved the energy puzzle.

Stacked plates

The secret of the system lies in its core, where thin metal plates act as heat exchangers (see diagram on previous page). Sears surmised that by running water through tiny spaces between the plates, he could boil it on one side of a plate using heat released by steam condensing on the other side. He stacked the plates to form a series of alternating boiler chambers heated by condenser chambers sandwiched between them—even though normally a condenser is colder than a boiler.

To accomplish this and make heat flow from the condenser to the boiler, the vapor is pressurized so it will condense at a higher temperature. Compressing the vapor costs energy, but Sears's design keeps the expense to a minimum. Because the still has an enormous amount of surface area for heat transfer, it's possible to condense steam with just a slight increase in its pressure, Sears explains.

"The real breakthrough came when we developed a method of operating the compression chamber at one pound per square inch [psi] above the boiler pressure," he says. Part of this method remains a trade secret. Conventional systems have to compress vapor by 5 to 6 psi above the boiler pressure to make it condense, so they need larger motors and more power.

The invention also conserves energy by recovering heat from warm liquids exiting the system. As impure cold water enters the still, it picks up heat from purified water and concentrated waste water moving in the opposite direction.

The stills are already purifying water for medical, pharmaceutical, electronics, and bottled-water companies. They come in two sizes, producing 600 or 5,000 gallons per day. Prices range from $15,000 to $65,000, but Sears says those figures will tumble as production increases.

Collecting pollutants

The machine removes pollutants such as iron, nitrates, pesticides, bacteria, chlorine, and toxins. It also concentrates them, so industries can recapture usable chemicals.

To test how well the purifier works, one firm polluted a distillation sample. "We dosed some water with 350 parts per million (ppm) of endotoxin," says John Wood, director of engineering at Barnstead Co., a Boston pharmaceutical company. (Water used for pharmaceutical purposes can't have more than 0.25 ppm of fever-producing endotoxin.) "After it went through the still, the water tested absolutely negative for endotoxin," Wood says. Other Environmental Protection Agency-approved laboratories fed the machine water spiked with chloroform and other toxins up to 184 times greater than EPA levels for potable water. The processed water had no detectable traces of the chemicals.

California aerospace engineer Charles Boitnott has used one of the processors in his San Mateo County home for more than three years. "Our water was so polluted with salinity and minerals it was too awful to drink," says Boitnott. "The county health officials red-tagged the house and wouldn't let us move in. I investigated other forms of water purification, and only this still would do the job. The county tested it thoroughly because they couldn't believe it would clean this water. But now we have the only building permit in the country that requires an operating still."

Boitnott and other users have had a few maintenance problems. The still's high-speed bearings often burned out because steam seeped through various seals and washed away bearing grease. Sears claims his firm has solved the problem with its "Aquaseal" invention: "We asked what would happen if we placed a disc on the impeller [the compressor's rotor], then cooled it. Theoretically, the steam should condense on the disc. Then the water droplets would be thrown by centrifugal force to the outer periphery, forming a liquid seal. We tried it, and it worked better than we ever imagined."

Other distillation methods with simpler designs require less upkeep than Superstill's processor but aren't as efficient. Among the machine's competitors, two of the most popular systems are the Phoenix 120 Martinstill, manufactured in Lincoln, Neb., and the Durastill, made in Kansas City, Mo. Both retail for $4,500 to $4,800.

"The major advantage we have over Superstill is that we have no moving parts, and therefore our maintenance level is very low," says Dave Martin, developer of the Martinstill. "But, on a large scale, nothing I've seen comes close to the Superstill processor on a per-gallon cost basis."

The Martinstill can produce pure water for about 10 cents per gallon, the Durastill for about 30 cents, and the Superstill purifier for about ½ cent, according to Gene Shaparenko, owner of Aqua Technology, a water store in San Jose, Calif. (Costs may vary, depending on regional energy charges.)

Sears says a small still requires 75 watt-hours per gallon and makes 25 gallons per hour. A larger model uses about 50 watt-hours per gallon and makes 200 gallons per hour. He projects the largest processor will run at 12 watt-hours per gallon, distilling 100,000 gallons in a day.

Tests by a federal laboratory showed the Superstill equipment distilling tap water required 66 watt-hours per gallon rather than 75 watt-hours claimed by the company. At seven cents per kilowatt-hour, that's 0.46 cent per gallon instead of the 0.53 cent per gallon claimed for the test unit. For salt water, energy costs were 0.60 cent per gallon instead of the 0.53 cent claimed.

Other purification methods, such as membrane technology and de-ionization, are sometimes even cheaper, but they're not as effective against bacteria.

Sears has big plans for his stills. "I see them being used by cities and water districts, in food processing, pollution control, and a variety of other applications," he says. Given a large enough machine, could a city like Los Angeles plug into the ocean and serve its population fresh, pure water? "Absolutely," says Sears. "Our engineers have already done calculations that show it would be cheaper for Los Angeles to use our technology and take water from the ocean than it is to pump the water from Mono Lake and the Colorado River."

Sears also hopes that oil firms will consider alcohol as an automobile fuel. "We can manufacture it for about thirty cents a gallon, and only a slight alteration to the car engine is needed." PS

DRAWING BY HUGO SALHUANA

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IMPROVE YOUR HOME

Projects and products for spring spruce-ups

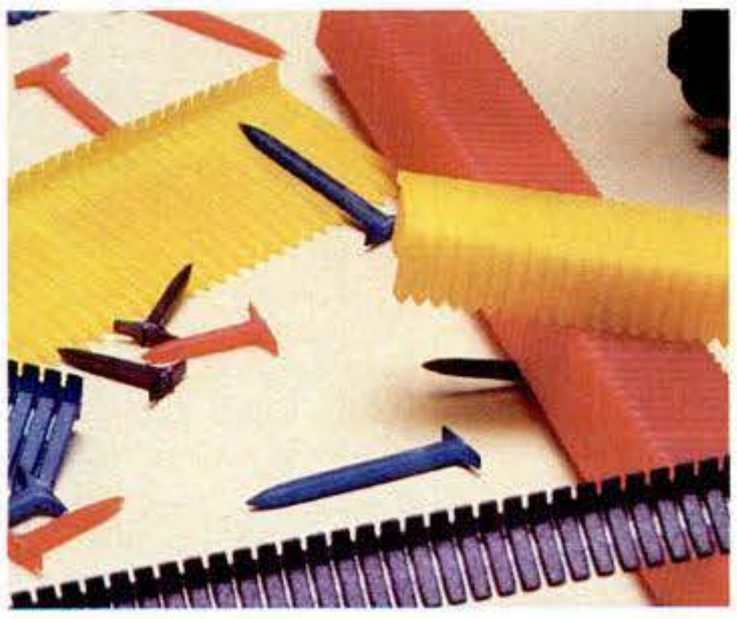
This year's spring home-improvement section is packed with ideas you can adapt to your own home—from major construction projects, such as your choice of backyard decks, to simple single-weekend built-ins using prefinished paneling. Also detailed: installations that'll save on cooling costs and add to your home's security.

Elegant decks

The patio-style deck at right is assembled from ready-made components—except for that massive planter of stacked 4×4s. The deck features built-in lighting and adapts to any flat yard. In contrast, detailed plans are also offered for an elevated second-story deck.

Plastic nails

Before you scoff, read this: Plastic nails (and staples, too) are nonmagnetic, and they won't corrode. You can saw, plane, or sand over them. And most surprising—they beat steel nails in pullout resistance. These odd fasteners must be driven with special pneumatic tools.



Paneling

Lighting is tucked behind the paneling in this entrance hall —one of eight innovative projects that use plywood paneling in unexpected ways. Photos and sketches show you how to use today's colorful variety of patterns in paneling to add distinction to drab rooms.

PLUS

• Flame spotter

An electro-optic fire detector looks for flames—not smoke—to give an early-warning alarm of fire in your home. It can spot a ¼-square-foot flame in a 30-foot-square room.

• Cop in a box

Now electronic sentries use technology to protect your home from thieves: The clever boxes sound an alarm, call the police for help, and even take a picture of the crook.

• Wiring tips

Adding an outlet or light switch to a room? There are methods that make the chore easier and safer. The pros offer tips the books don't tell you about.

• Whole-house fans

Send hot air, not your cooling bills, through the roof this summer: Install a ceiling exhaust fan, and save your air conditioning for the scorchers.

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IMPROVE YOUR HOME

ELEGANT DECKS —low or high

The terrain of your backyard and the style of your home will determine which of these designs is for you. Both add a bi-level "outdoor room" for relaxation and entertaining—and both are built to last for years.

By AL LEES

LOW

Alfresco entertaining in the evening is the pattern at the northern Illinois home of Marc and Barb Posner—and they had the setting for it: Their spacious yard backed onto a wooded area. But their builder had provided only a concrete stoop outside the back door from the kitchen. And the sliding patio door from the living room was an awkward step down to bare lawn. The grass stayed damp after a rain, and there was no adequate outdoor lighting; guests moved indoors at dusk.

The Posners took their problem to Wickes Lumber's local building-supply center. There they found a batch of well-designed deck plans, one of which was quickly modified to fit their needs—the deck flows around to fill the setback in their back wall, connecting the two rear doors. They chose Deck Plank Wolmanized lumber—pressure-treated planks in lengths of 8 to 16 feet. This 5/4 × 6 decking is lighter and cheaper than nominal two-inch stock. The latter's actual thickness is 1½ inches against Deck Plank's 1¼. And the Posners found that the rounded edges lent themselves to built-in benches and steps, as well.

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PHOTO BY MICHAEL KELLY

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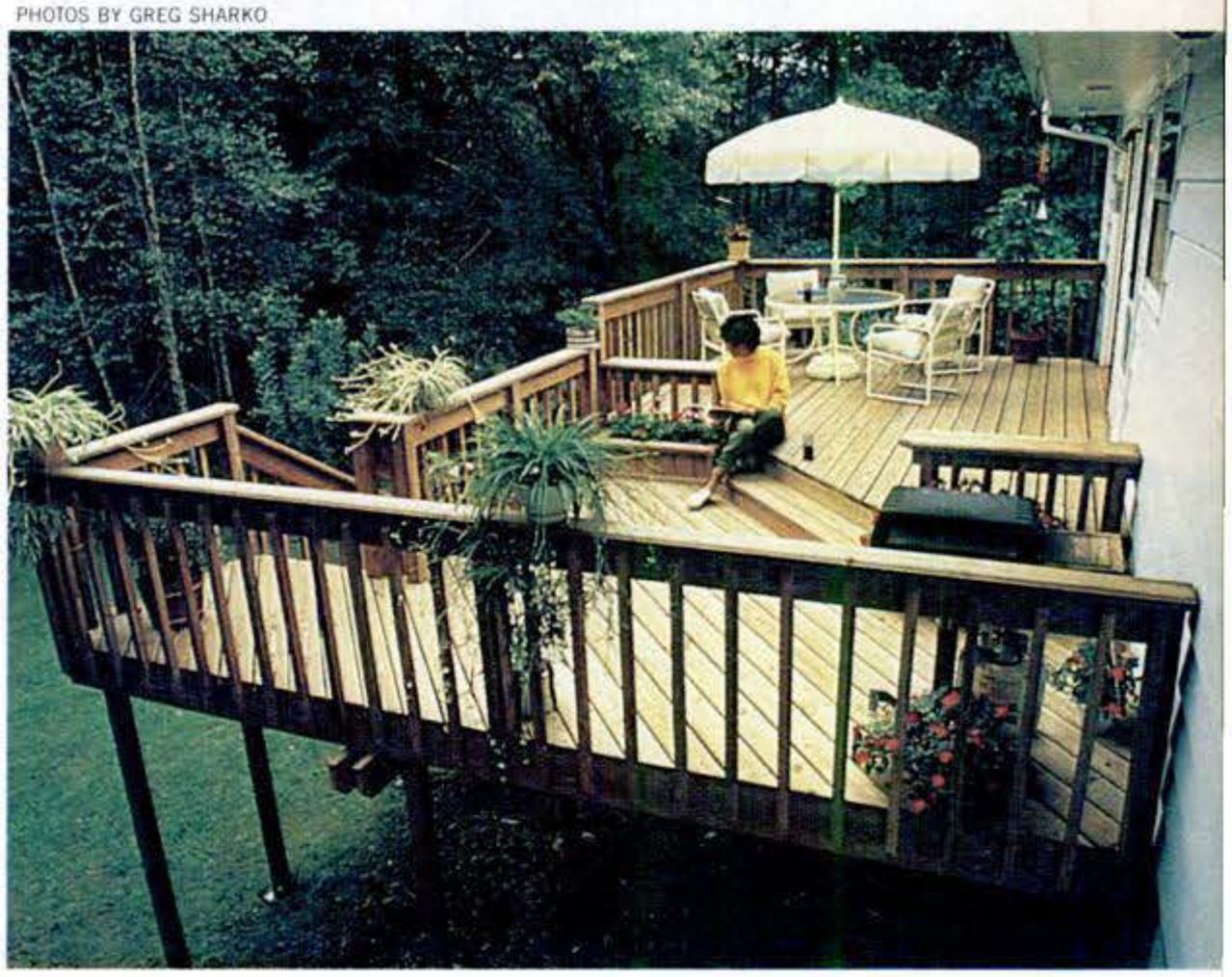
PHOTOS BY GREG SHARKO



The feature that gives this second-story deck distinction is the oblique step-up between activity levels. It lets you vary the plank pattern and build in a pair of handsome planters.

HIGH

The access to their steeply sloping backyard was all wrong. As Rick and Sandy Voorhees bought it, the house made them step out onto a precarious perch of a platform at the head of a long stair that descended—incredibly—in the wrong direction: The garage, tucked under the kitchen, is at the end of a steep driveway off to the *left* in the photo above; but the old stairway led off *right* to a blind corner of the yard, forcing the homeowners to about-face on its base slab.

The yard itself, however, was a glory, surrounded by hardwood forest. So the Voorhees called on New Jersey contractor Mike McNally to create a deck worthy of their view. The design that resulted has transformed their modest home, and the Voorhees family now spends most of the year enjoying the beautiful site. Even the view from inside has been enhanced: A puny rear window to the left of the door (turn page for the "before" shot at far right) was replaced with a sliding patio door that draws the outdoors in, year round. As a bonus, it offers access to the deck from the dining room as well as through the old door from the kitchen.

All construction was handled by two workers. A great difference between a ground-level deck and an elevated one is that the latter doesn't rest directly on concrete piers but is supported by posts (usually, as here, 4 × 4s). In both cases, work must start with a staking out of the deck on the ground, using the house wall as a base line. But with an elevated deck, the positioning of the piers—poured flush with ground level or just slightly above—is more critical. McNally always uses metal post bases. These are fastened to each pier with an anchor bolt, set into the concrete after the pour. The best type has a metal platform that keeps the post from direct contact with the concrete to spare the porous butt from perpetual dampness. McNally poured nine piers (in Sonotube forms set in holes dug down to the frost line), later adding a pier-footed pad for the stair stringers to rest on.

Another advantage of metal post bases is that they permit some adjustment, so if you position your poured footings a bit out of line, you can shift the location of the post on the pier enough to keep it plumb with the overhead framing it ties into. Note in McNally's initial construction photo that he and his helper raised two post-and-beam assemblies first, holding them erect with staked

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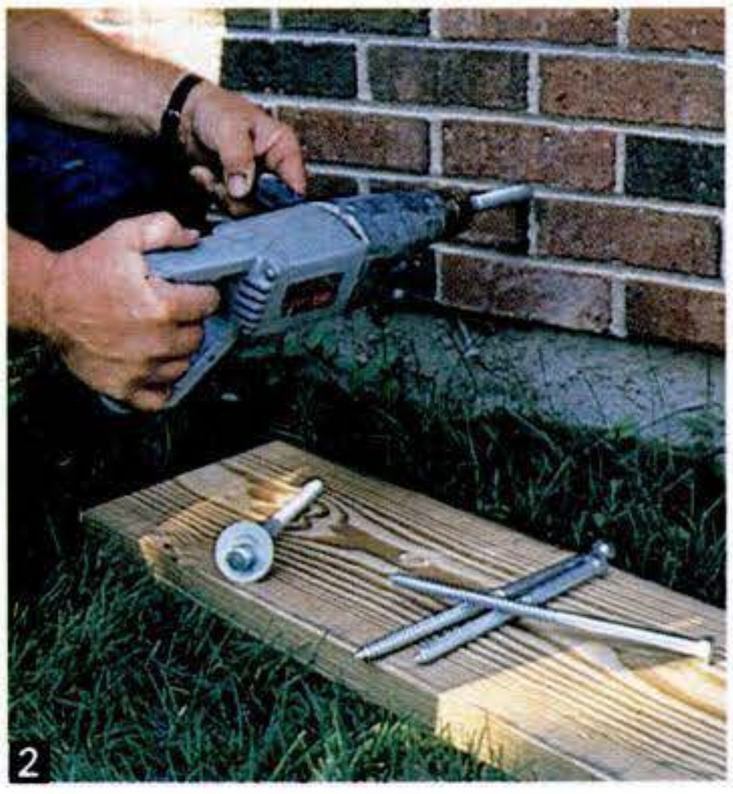
LOW

1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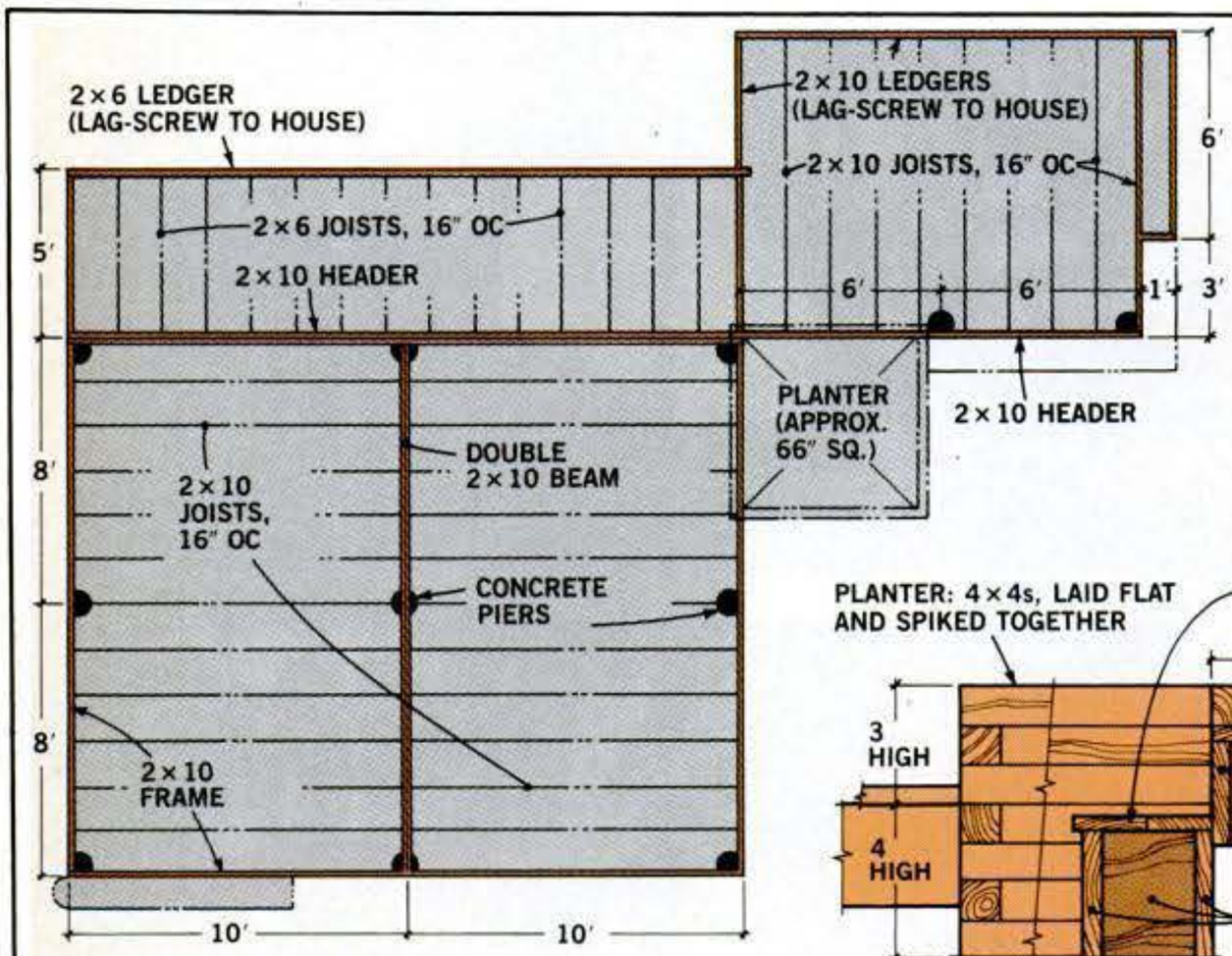
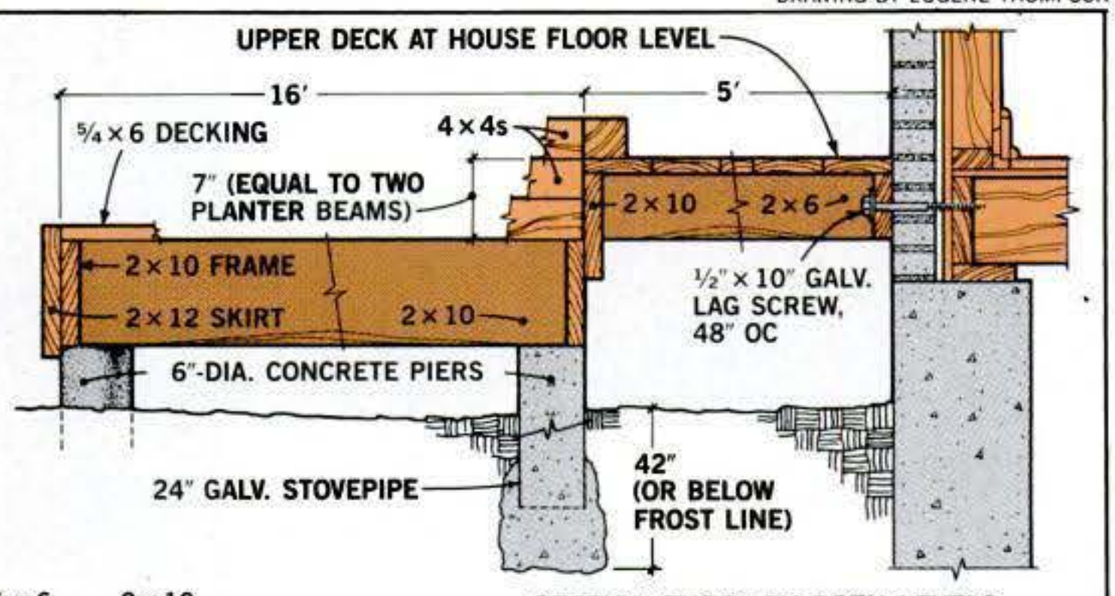
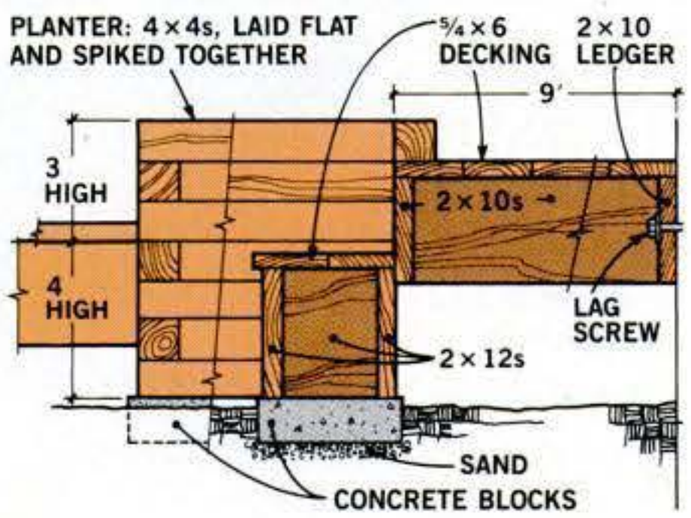
DRAWING BY EUGENE THOMPSON



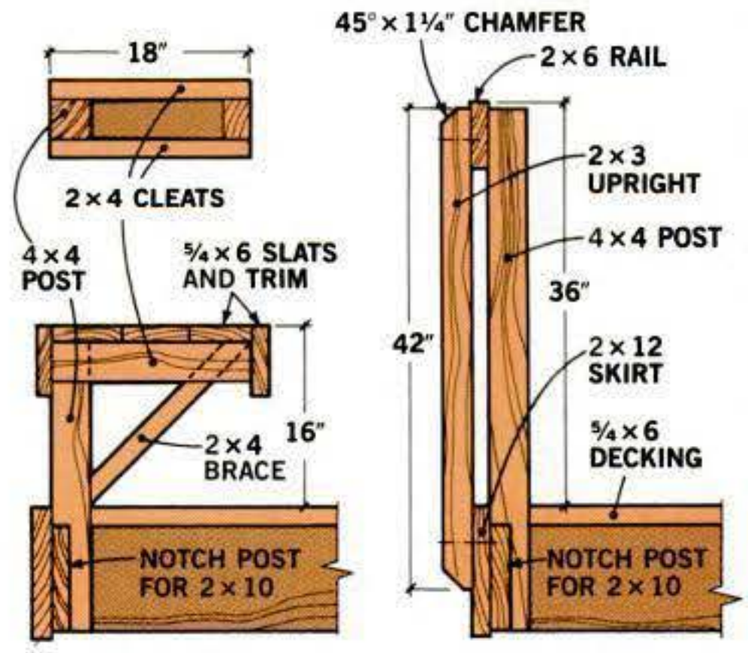
FRAMING AND PIER LAYOUT



SECTION THROUGH BOTH LEVELS

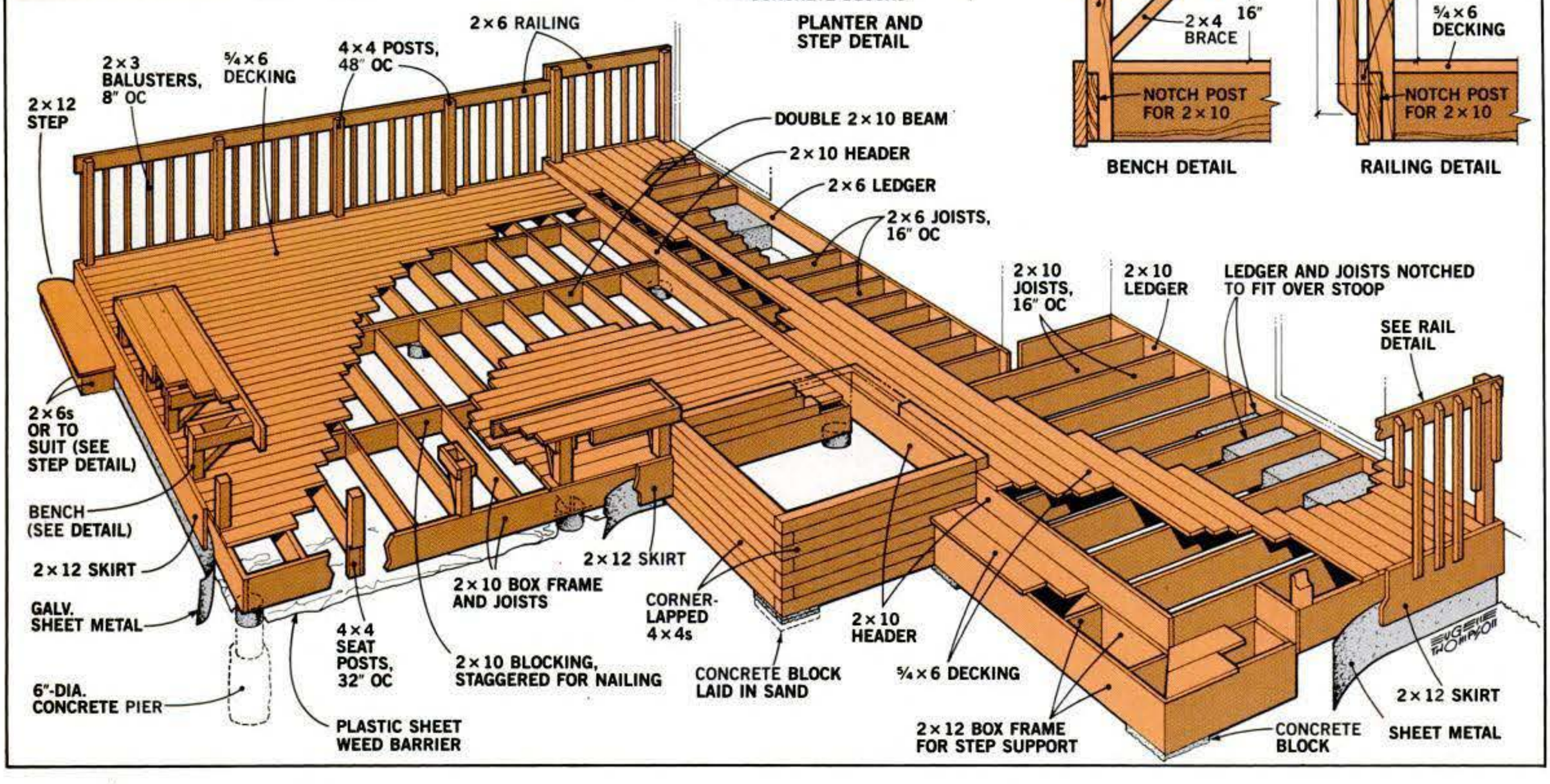


PLANTER AND STEP DETAIL



BENCH DETAIL

RAILING DETAIL



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1 Once the perimeter of the deck was staked out, holes for 11 concrete piers were drilled with a power auger, to below frost line. 2 Ledgers are the only part of the support frame to be anchored. Holes were drilled at 4-ft. intervals through joints in the brick veneer so lag screws could be driven into the house's band joist. 3 Rather than break up existing concrete stoop, the 2 × 10s used for both ledger and joists were notched over it; this still keeps the top of the deck below the sill. 4 Deck Plank lumber is nailed on, butted snug so that, as it seasons, ⅛-in. cracks will open for drainage. Planks notch around posts that are bolted through the frame. 5 To keep nesting animals out, aluminum flashing is nailed along perimeter joists, then marked with skirt boards. 6 Planter section is made of lap-corner 4 × 4s down to ground level. After they're spiked together, edges of top units are rounded with a router to match the edge treatment of Deck Plank lumber; then the pit is filled.

The deck frame rests on a total of 11 concrete piers. Packaged concrete was mixed and shoveled into the holes. As it reached the top, a two-foot length of six-inch-diameter galvanized stove pipe was inserted and adjusted to the proper height for each pier; the remaining mix was shoveled into the pipes, which became permanent forms.

The tops of these piers must be flat and at proper heights, because the frame of the deck simply rests on them, without anchors. The deck is actually fastened only to the house walls.

The railing the Posners chose is a modification of the standard precut component system available from Wickes. The final touches were Malibu low-voltage lights installed around the perimeter, and the two groupings of Sanibel patio furniture from Samsonite. PS

HIGH

props while cantilevering the 2 × 8 joists out from the house ledger atop the double beams. So it's essential that ledgers be well anchored to the house frame or foundation, and that they be absolutely level. For this bi-level deck, ledgers are set at two different heights, with an overlap at the center. Metal joist hangers are nailed to the ledger on 16-inch centers, for the joists to drop into.

At the right end of the deck, four joists extend an extra four feet to create a platform from which the steps descend. Since the vertical drop from lower deck level to the ground was 8½ feet, McNally felt a continuous run would have been tiring—both to the legs and to the eye. So he constructed a platform about halfway down. This allows a welcome pause while ascending, and adds to the architectural design.

This platform is nothing more than a mini-deck placed in alignment with the staircase. McNally likes to keep the tread-rise ratio as close to 12/6 as possible in an outdoor stair. This meant the use of two 2 × 6 planks for each tread.

Of course, all lumber used in construction was pressure-treated—this should be standard for all deck projects, unless you're using redwood or cedar. For the decking itself, McNally spaced the 2 × 6 planks ⅛ inch apart. "Natural shrinkage will increase the gap," he says, "but not excessively."

The posts that support the deck railing are notched and bolted to the deck's support frame, as detailed below.

Continued

Soaring cantilever of initial framing (top photo) will establish exact lengths to cut support posts that show in the second photo and drawing (next page). Both deck levels are anchored to the house by ledgers lag-screwed to existing framing. Scars on the wall in the top photo show position of old stoop and stairway, removed for new construction.

Copyrighted material

HIGH

They're also rabbeted at the top to take the sub-rail. (Note that the rail is an assembly of two 2×6s joined to form a T.) The balusters are 2×2s trimmed at a 45-degree angle at both ends and nailed in place, spaced six inches apart. To avoid corrosion stains, hot-dipped galvanized fasteners were used throughout.

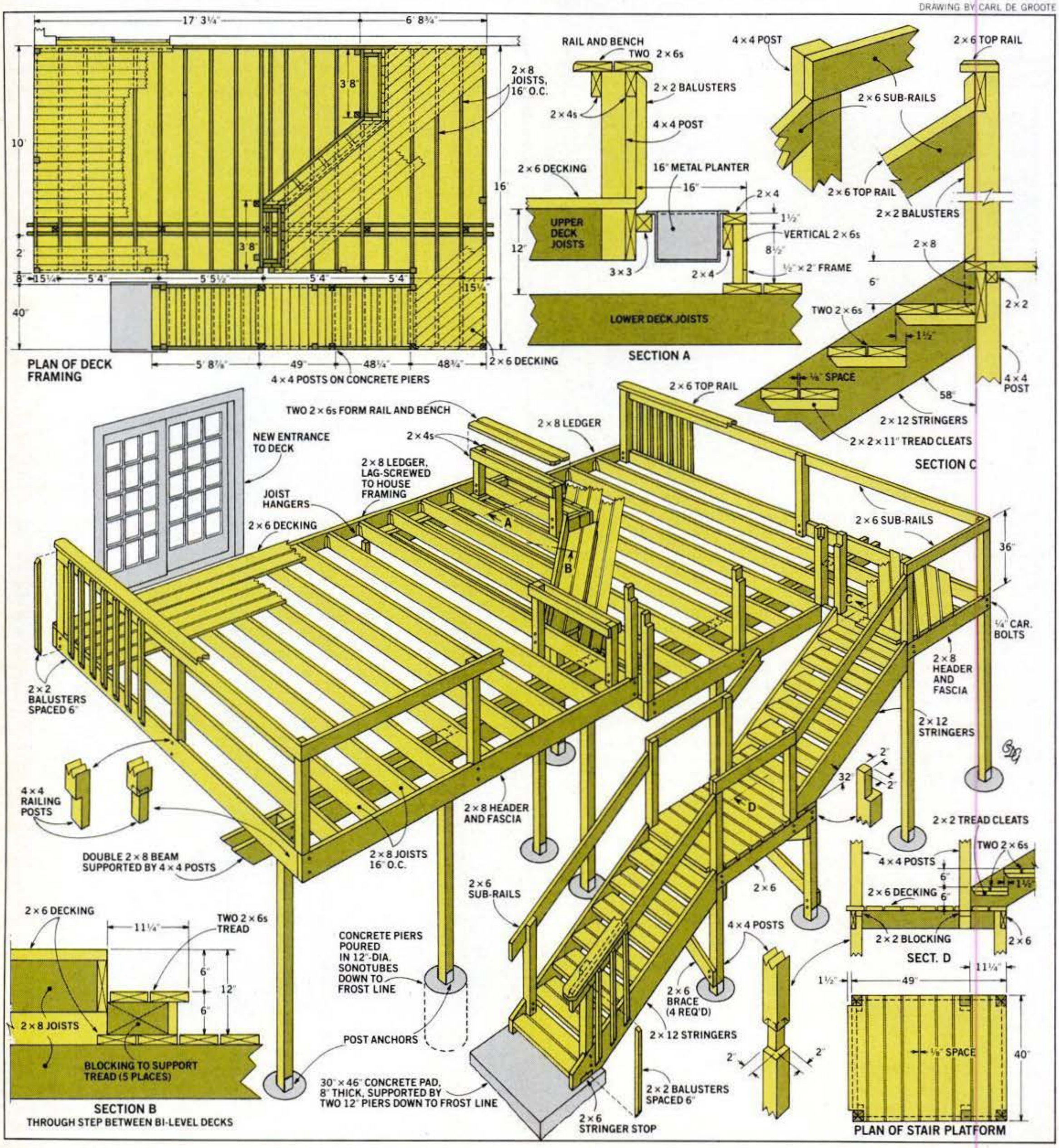
Planters fill the voids to either side of the steps between deck levels. These boxes were created by nailing pressure-treated 1×4s to a 2×4 frame. When assembly was complete, careful inside measurements were taken so metal inserts could be made at a sheet-metal shop.

Once all decking was laid, attention turned to replacing that small window with a patio-type glass door. Since this was a bearing wall, temporary support was required while the old window was removed and a beefed-up header was installed so that a wider opening could be cut—the rough opening specified by the door manufacturer.

When opening any wall, you must look for runs of electric wires, water lines, or heating ducts. The house shown had both electric and heating lines passing beneath the old window and into the kitchen. These runs had to be rerouted back down to the basement, across, and up to the kitchen. If you're not comfortable with such rerouting, call in professional help; but in any case, cut with caution and only after a thorough check.

Once the new header was in place, the door was inserted from the outside, insulation was stuffed in the cracks, and casing was applied. PS

DRAWING BY CARL DE GROOTE



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Optical fire spotter

IMPROVE YOUR HOME

Rather than detecting smoke or other products of combustion, a new rapid-response room fire alarm uses electro-optic technology to spot flames as they form.

By DAVID PETRAGLIA
Photo by Jim Richards

Where there's smoke, there's fire. The old adage still holds true, but sometimes the wait to detect smoke or other products of combustion—as photoelectric and ionization-type fire alarms must do—means a delay that could endanger lives. That's why Fire Sentry Corp. has developed the Room Sentry line of early-warning fire sensors, which sound an alarm within a second of detecting a ¼-square-foot flame in a room up to 30 feet square.

The Room Sentry's sensor and alarm circuitry is enclosed in a high-impact ABS plastic box the size of a home wall thermostat. The alarm provides the same detection capabilities as industrial units costing five to 10 times more. The sensors are designed to operate in single-room environments in houses (there's a special kitchen model), hotel rooms, offices, recreational vehicles, boats, and even airplanes.

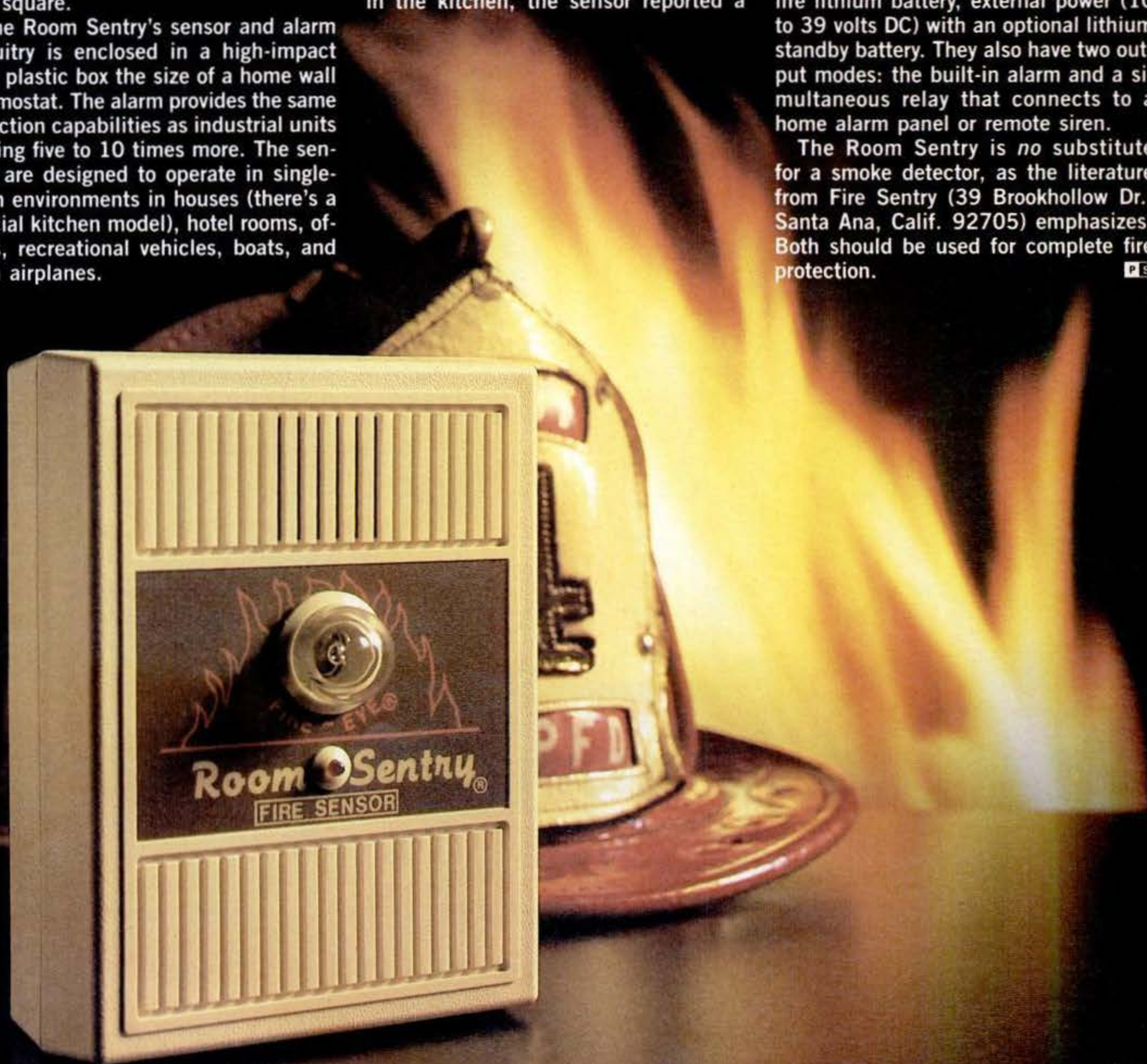
After I received the basic $374 Room Sentry and connected the battery, I left the unit on the stairs for a moment while I checked my fireplace insert. No sooner had I opened the insert door than the Room Sentry emitted a pulsing (85 decibels at 10 feet) blast from its piezoelectric sounder. The sensor had detected the electromagnetic emissions of the flame from 18 feet away.

As I moved the Room Sentry around the house to test it in different circumstances, it never failed to speak up in the presence of an open flame. One night in the kitchen, the sensor reported a flare-up of some pork chops on the grill (from 20 feet away) before my wife or I had even heard the sizzle (the exhaust fan was on).

The bulblike device on the front of the basic unit, the business end of the sensor, is tuned to the ultraviolet spectrum. Other more expensive models employ the visible or the infrared spectra as well as the UV to verify the presence of flames in special conditions, such as bright sunlight, so as to reduce false alarms.

Room Sentries have several power options: a nine-volt alkaline battery, a long-life lithium battery, external power (10 to 39 volts DC) with an optional lithium standby battery. They also have two output modes: the built-in alarm and a simultaneous relay that connects to a home alarm panel or remote siren.

The Room Sentry is *no* substitute for a smoke detector, as the literature from Fire Sentry (39 Brookhollow Dr., Santa Ana, Calif. 92705) emphasizes: Both should be used for complete fire protection. PS



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PLASTIC

Are we serious? Indeed we are. And not only plastic nails, but staples too. These fasteners, driven with special pneumatic tools, are nonmagnetic, won't corrode, and beat their steel counterparts in pullout resistance.

By PHIL McCAFFERTY
Photo by Greg Sharko

I first saw them strewn on a table at a large hardware exposition: cartridge-style rows of nails, finishing nails, and staples in a rainbow of hues—obviously made of *plastic*.

At the booth, I learned that these nutty notions were made in Japan (where else?) by Kotoko Co. under the trade name Kowa, and are imported by Marukyo U.S.A., 511 East Fourth St., Los Angeles, Calif. 90013.

As I listened to the sales pitch, though, I began slowly to withdraw my tongue from my cheek. Plastic nails and staples are nonmagnetic, and they won't rust or corrode. They won't rip your paper when you sand over them, and you can saw or plane them without damaging your tools. These nails can be ordered in just about any color, I learned, so they can be almost invisible. The biggest surprise: They have better pullout resistance than similar-sized metal fasteners, I was told.

Naturally, I arranged to try these oddities myself.

Driving a plastic nail with a hammer (I had to try) is almost like trying to pound home a cooked noodle. You must use the special Kowa pneumatic stapler and tacker guns, which zap the fasteners home before they know what happened. The supplier recommends at least 100-psi air pressure to run the guns. I tried them with my one-horsepower, 90-psi compressor, and it drove even the one-inch fasteners (the longest) satisfactorily.

The plastic fasteners worked just fine on all softwoods, plywood, and even oak. They collapsed when I tried to shoot them into the cross grain of hard maple, but they easily went into the end grain. I had mixed results on particleboard. The fasteners did not work on high-density hardboard.

In company tests of pullout resistance, I learned from the U.S. distributor, the plastic nails beat steel nails by a long shot. Two one-inch plastic nails and two steel nails of equivalent size were driven into wood, and the force required to break the nails or pull them out was measured. (While steel nails pull out, plastic nails tend to break under excess stress.) It took from 9.4 to 13.4 pounds of force to break off the plastic nails over a temperature range of +140 degrees F to −4 degrees F. The steel nails pulled out at forces of 2.2 to 3.1 pounds.

The superior pullout resistance is due to the fact that the plastic melts slightly from the friction of insertion and actually bonds to the wood, the supplier explained. To check that, I drove plastic nails in near the edge of a piece of wood so that the wood split off. I then looked at the exposed nails under a magnifier. Sure enough, the nails had tiny wood fibers stuck on, looking something like the fur on a caterpillar.

But in shear tests, the steel nails beat the plastic. When wood blocks, nailed together with one-inch nails, were forced laterally, the steel nails bent at 13.7 pounds of force while the plastic nails deformed at 10.6 pounds.

The new plastic fasteners are being used for upholstery work, particularly in outdoor applications; for applying siding and roofing; for making trellises, mailboxes, and birdhouses; and in boat-building. The standard color is semi-opaque white, but the fasteners can be dyed a variety of colors or even made from specially pigmented plastic.

The guns are pricey, about $400 each. The fasteners run from about $6 to $12 per 1,000. PS

Plastic fasteners must be driven with special air guns, and a different one is required for the nails, finishing nails, and staples. Three sizes of each nail (5/16 in. to 1 in.) and four sizes of staples (3/8 in. to 1 in.) are now available in the U.S.

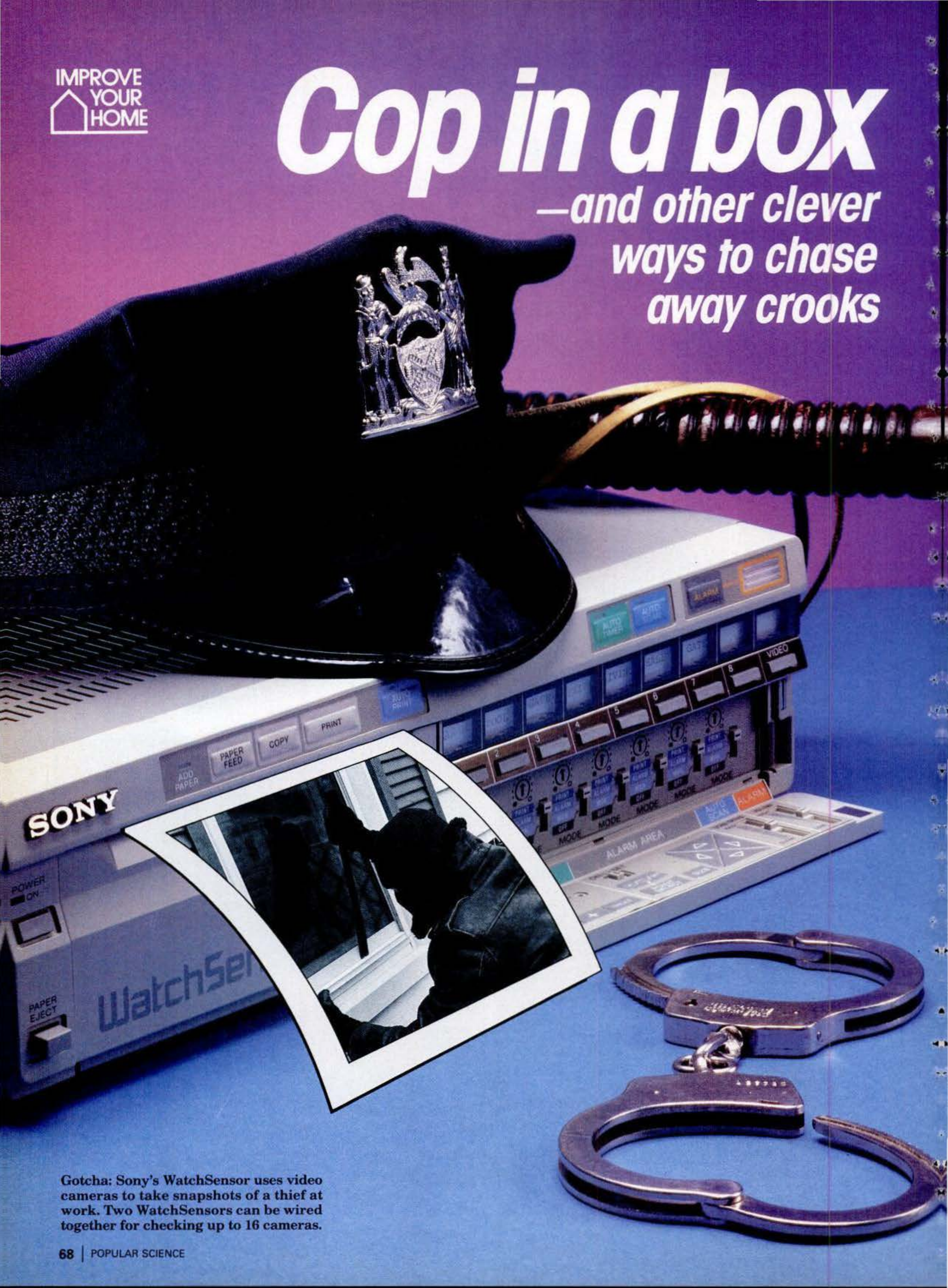
NAILS

IMPROVE YOUR HOME

IMPROVE YOUR HOME

Cop in a box

—and other clever ways to chase away crooks



Gotcha: Sony's WatchSensor uses video cameras to take snapshots of a thief at work. Two WatchSensors can be wired together for checking up to 16 cameras.

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Eyes of silicon. Brains of microchips. These silent sentries use advanced technology for added features and fewer false alarms while guarding your home.

By G. BERTON LATAMORE
Lead photo by Greg Sharko

I reached out to touch what looked like a wall-mounted TV set. As I did, its screen suddenly burst to life, and I snapped my arm back to my side as a piercing alarm reached my ears. "There's an intruder," said Tom Riley, president of Unity Systems, as he pointed to the rapidly changing display in front of me.

A floor plan of the house appeared on the screen. Then one area—an upstairs bedroom window—began flashing. "The thief entered the bedroom," said Riley. "He's going through the house." As the intruder moved, the screen showed his progress down hallways and into other rooms. All the while, his actions were recorded on a floppy disk by the system's computer. If this had been a burglary instead of a demonstration, the police would have been on the way.

The system I was watching—the Home Manager, developed by Unity Systems—typifies home security products that use advanced technology to beat the thief. Experts predict that all new models will use state-of-the-art electronics to spur another era in home security.

What techniques are being used in this new generation of security products? How will future systems improve on the current crop? To find out, I spoke with engineers, product planners, and experts in the security field. I learned that only in the last year has digital chip technology made its full impact felt in home security. The result has been a quantum leap in system ability, ease of use, and reliability.

Have it your way

My first step took me to Unity Systems' headquarters, in Redwood City, Calif., where Tom Riley unveiled his firm's new Home Manager system. "The screen is touch-sensitive," Riley told me, tapping the display with his finger tip.

As I touched the screen, the customized floor plans identified each security sensor and its status: armed, off, or malfunctioning. Home Manager is zoned, so I could arm individual room sensors or areas.

At up to $10,000 each, Home Manager is far from the primitive key-

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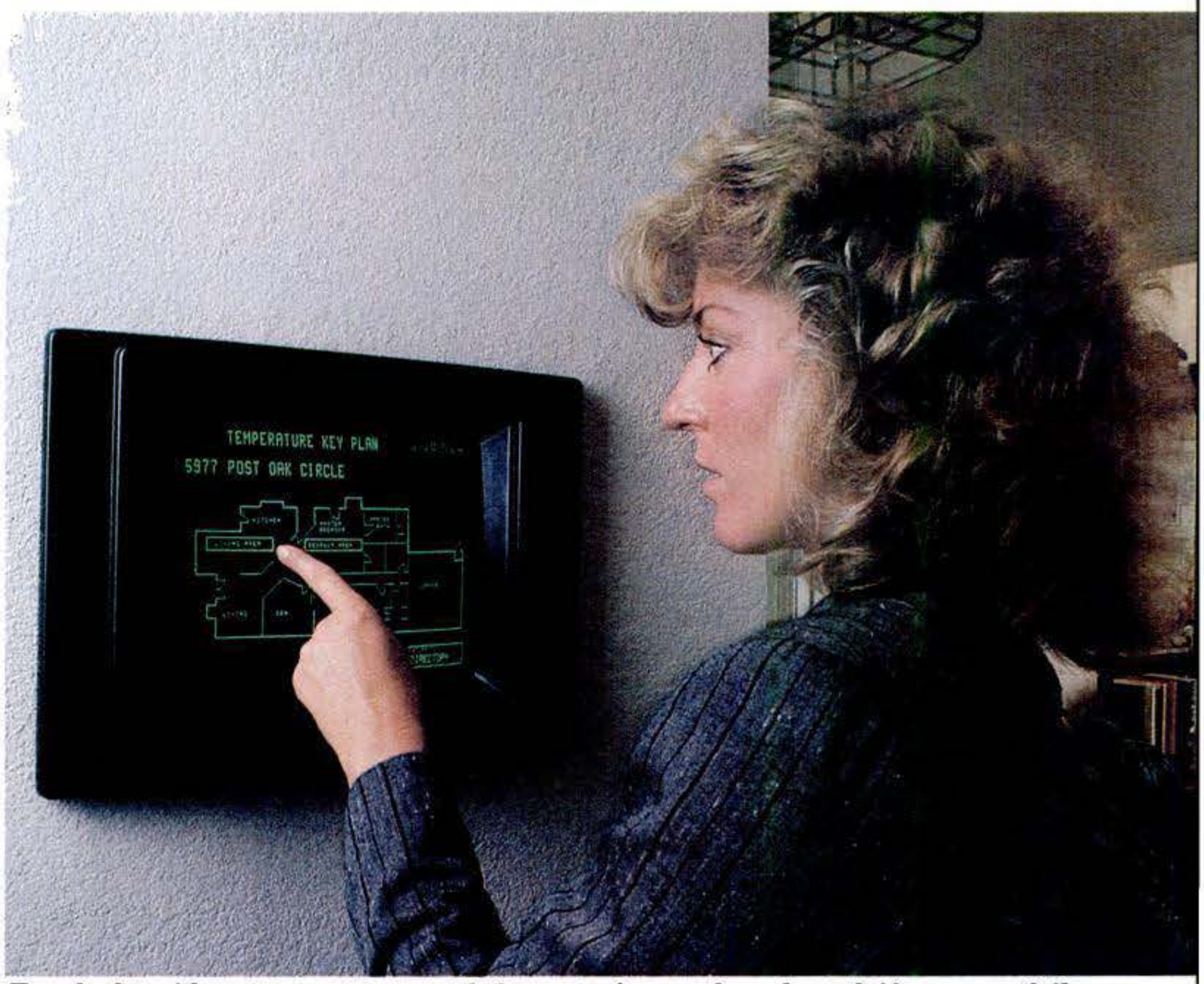

Touch the video screen to control the Home Manager. Multiple levels of security can be selected; if a sensor fails, the system isolates it automatically.

PHOTO BY GREG SHARKO

Schlage's kit of transmitters, control box, and battery backup is made for do-it-yourself installation. Automatic dialer (not shown) is an option.

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operated security boxes of a few years ago. Elaborate systems like this require professionals to string wires through walls to connect sensors to the control panel, which sounds the alarm.

However, new do-it-yourself systems are simpler to install: There are no wires. Instead, room sensors trigger tiny battery-powered transmitters that communicate with the control system via short-range radio broadcasts. Early wireless systems had reliability problems—caused by stray signals from CB radios or garage-door openers—but more recent digital designs have changed that tarnished image.

"Our Keepsaver system uses an eight-bit digitally coded signal," says Greg Markes, consumer electronic products manager for Schlage Lock Co. "And the code has to be received by the control unit four times in less than a second to be acknowledged." That severely lessens the odds of a false alarm.

Keepsaver uses digital circuits for communications, too. When an alarm sounds, an optional dialer seizes the phone line and automatically calls a computer at Schlage's offices. "The dialer identifies itself by using a digital code and indicates the type of alarm—police, medical, or fire," says Markes. "The computer matches the identification number and alarm code with information stored in its data base. It then tells a human operator what to do and whom to call."

At $179 for a starter system and $99 for the dialer, Keepsaver is one of the lowest-cost wireless systems available. But it's not the only one.

For example, AT&T's Security System 8000 includes a smoke alarm, and there's a personal transmitter that you take with you. Press its button for help if you hear a prowler or if there's a medical emergency. Tandy Corp.'s Safehouse and Universal Security Instruments' Perim-A-Tron work similarly to Schlage's system, but they have an automatic battery test. These units sound a special alarm if a transmitter should fail due to low power.

Black & Decker's system, now being test-marketed (price not set, but about $500), is wireless, too, but it doesn't use over-the-air transmissions. "If a sensor detects a break-in," says product manger, Lon Mears, "it emits an audible sound. The sound is digitally coded and intended to be heard by a microphone inside the controller box."

Once the controller hears the electronic yell for help, it sounds the general alarm by sending a signal via the house wiring to remote modules. "The modules blink the house lights and activate the sirens," says Mears.

If a sensor is too far from the controller to be heard, another module, called a relay, is plugged into a wall outlet. The relay picks up the sound in the room and alerts the controller via house wiring.

Smile

"It's an electronic peephole," says Bill Yen, Sony's marketing director.

I'm looking at a new video surveillance camera. Because it uses a tiny solid-state charge-coupled device to see an image, the entire package fits in the palm of my hand.

This is just one of several security cameras made for residential use. For example, both Sony and Panasonic have models made for the front door. When someone rings the doorbell, you turn on a special TV—which is safely *inside* the house—to find out who's *outside*.

The $620 Sony system, called WatchCam, comes with an adapter to let the camera replace a conventional door peephole. But according to Yen, the camera is finding other "security" uses, too. "You can mount the camera over the baby's crib," he says, "or use one to watch the backyard pool."

> *"One day you'll walk up to your front door and say 'Hello' —and it will swing open for you"*

An upgraded version of WatchCam is Sony's WatchSensor. This $3,300 system monitors up to eight cameras, and each can be programmed to watch specific areas in its field of view.

If a thief enters the protected areas, WatchSensor can sound an alarm, call the police, and take up to 200 snapshots of the intruder using its built-in video printer. The printer makes a picture in about seven seconds, and up to four pictures can be stored in WatchSensor's memory. So the system can capture information from several cameras at the same time.

What happens if *you* walk past the window on your way to a late-night snack? You become a statistic.

"The largest single source of false alarms is caused by the homeowner," says John C. Johansen, marketing director for residential systems at ADT in New York. "Someone in the house violates the system and doesn't know how to disarm it before the signal goes out."

To deal with the problem, ADT's $995 system includes a code word. If the alarm is tripped and the system calls one of the company's monitoring stations, the first thing the operator does is call you back. "If you say the code word," says Johansen, "the operator cancels the alarm." If not, the police are at your door.

While call-back schemes such as this handle human errors, technology is at work to lessen the chance of electronic blunders. The newest thief detectors use dual-motion sensors. These combine two different sensor technologies into a single small device, and both must agree there's an intruder before the alarm sounds.

"A passive infrared sensor can be fooled if it's mounted opposite a window and the sun suddenly strikes it," explains Robert Bergener, a leading expert on security systems and president of Bergener and Associates, of Rockville, Md. "And an ultrasonic detector can be fooled if a circulating fan turns on and moves the air in the room." But in a dual-detector system, both need to be tricked at the same time to cause a false alarm.

"That usually won't happen," says Bergener, "because the ultrasonic sensor ignores the sun and the infrared detector ignores the fan. The system goes off only when the detectors find something warm and moving."

Warm and moving? Could that include pets, wildlife, and non-security-minded children? Yes, and to security designers, all three pose recognition problems that will take years to overcome. But plans are already underway.

According to the experts, future home security systems will change dramatically because of two relatively new technologies: digital image analysis and voice recognition.

Image analysis uses a special computer technique to determine what—or who—a camera is seeing. Voice recognition allows the computer-controlled security system to understand your orders. Though both technologies are in limited use today, it will be some time before they are perfected to a level that allows your house to recognize the smile on your son's face.

But tomorrow's vision systems are already in the minds of today's visionaries. Says ADT's Johansen: "One day you'll walk up to your front door and say 'Hello'—and it will swing open for you." PS

SELECTED SECURITY-SYSTEM MANUFACTURERS

ADT Systems, One World Trade Center, New York NY 10048; **AT&T Consumer Products Div.,** 5 Wood Hollow Rd., Parsippany NJ 07054; **Black & Decker,** 10 N. Park Dr., Hunt Valley MD 21030; **Panasonic Co.,** 1 Panasonic Way, Secaucus NJ 07094; **Schlage Lock Co.,** Box 3324, San Francisco CA 94119; **Sony Security Systems Co.,** 15 Essex Rd., Paramus NJ 07652; **Tandy Corp.,** 1700 One Tandy Center, Fort Worth TX 76102; **Unity Systems,** 2606 Spring St., Redwood City CA 94063; **Universal Security Instruments,** 10324 S. Dolfield Rd., Owings Mills MD 21117

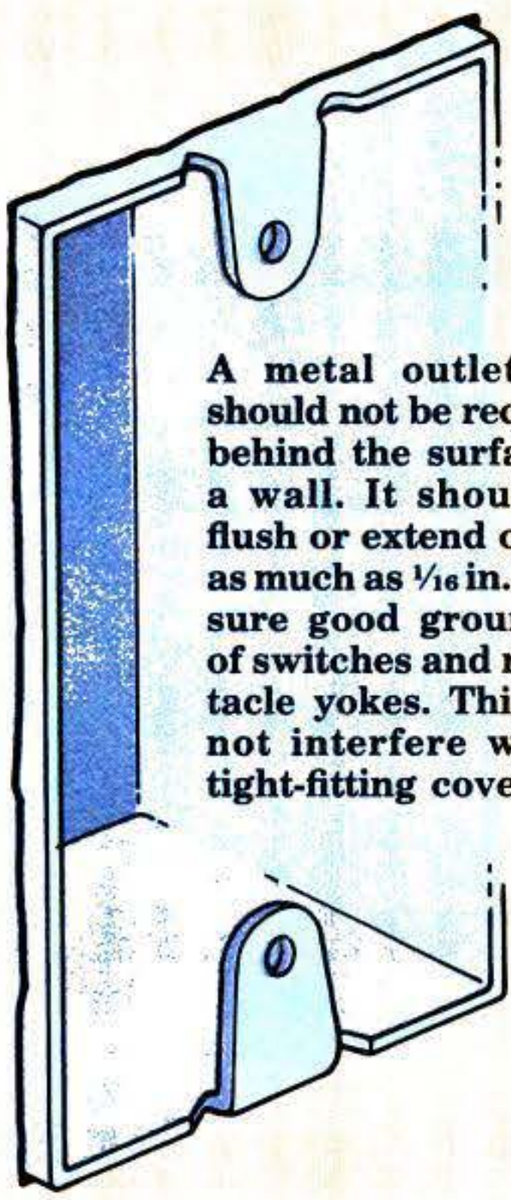
Wiring tips from the pros

—5 neat tips the books don't tell you about

By RICHARD DAY

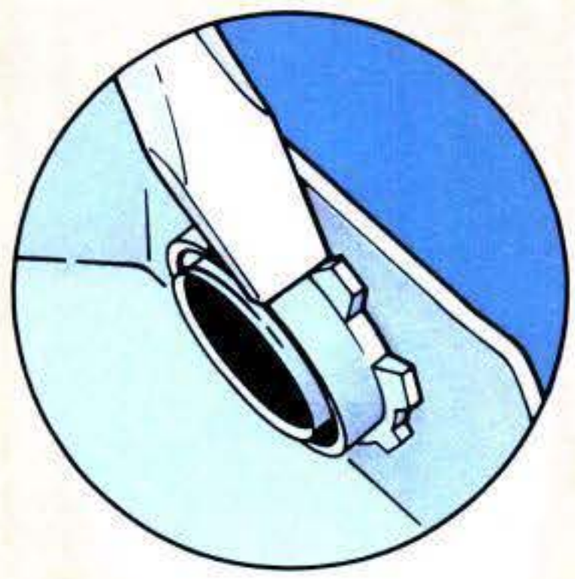
A receptacle here, a light up there, and maybe a switch by a doorway. Adding new electrical devices and wiring to your house is fairly easy, but there are a few things you should know before you go to work.

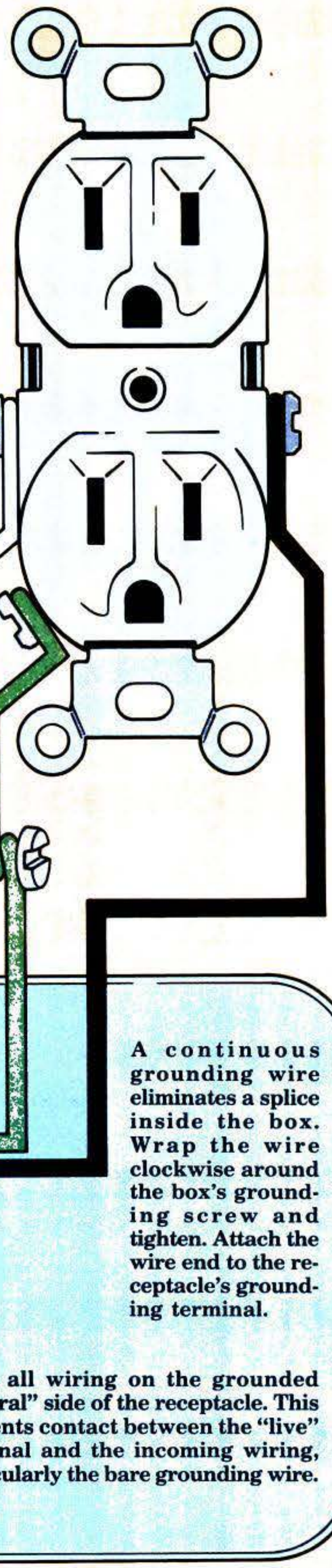
Here are some techniques the professionals use when adding the outlet boxes required for all receptacles, switches, and lights. The pointers are simple but valuable for a quick, safe, trouble-free installation. PS



A metal outlet box should not be recessed behind the surface of a wall. It should be flush or extend out by as much as 1/16 in. to ensure good grounding of switches and receptacle yokes. This will not interfere with a tight-fitting cover.

The locknuts included with cable connectors have raked teeth that secure the connector to a metal outlet box and make a good ground connection (for metal-jacketed wiring). Install the nuts with the teeth against the box, and tighten (by pushing with a screwdriver) until the teeth bite into the metal.





A continuous grounding wire eliminates a splice inside the box. Wrap the wire clockwise around the box's grounding screw and tighten. Attach the wire end to the receptacle's grounding terminal.

Keep all wiring on the grounded "neutral" side of the receptacle. This prevents contact between the "live" terminal and the incoming wiring, particularly the bare grounding wire.

The National Electrical Code does not limit the number of cables that can be placed through one connector. However, because two or more cables in a connector can cause excessive heat, a multi-cable connector should be rated by Underwriters' Laboratories for multiple-cable use. Tighten the connector securely over the cables, and staple the cables within 12 in. of the box.

DRAWINGS BY MITCHELL J. ALBALA

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IMPROVE YOUR HOME

Paneling in

Plywood paneling isn't just wall covering. You can build with it, using it to face your lumber-framed projects and built-ins, and to add architectural details.

By AL LEES

Any picture that flashes in your mind when someone says "plywood paneling" is likely to be out of date. In the last couple of years, the range of patterns and colors available in prefinished panels has dramatically increased. You're no longer limited to a selection of wood grains, whether real veneers or photographic reproductions. Now you can choose panels with bold or subdued patterns, stripes, florals, and pictorials that remind you of wallpaper. The newest paneling products reproduce such surfaces as grass cloth, woven-reed matting—even marble. And some of the designs are embossed to provide textures for even greater realism.

Unlike wallpaper, however, these panels give you a tough, durable surface that not only can be scrubbed, but resists dents and tears as well. And if you tire of the look after a time, you can always resurface with paint or paper.

Today's broader choice in plywood paneling inspired me to seek out projects in which the material would be used structurally—not just to cover a flat wall. The home improvements shown here are the result—all but one of them designed by Michael Cannarozzi for the Plywood Paneling Council

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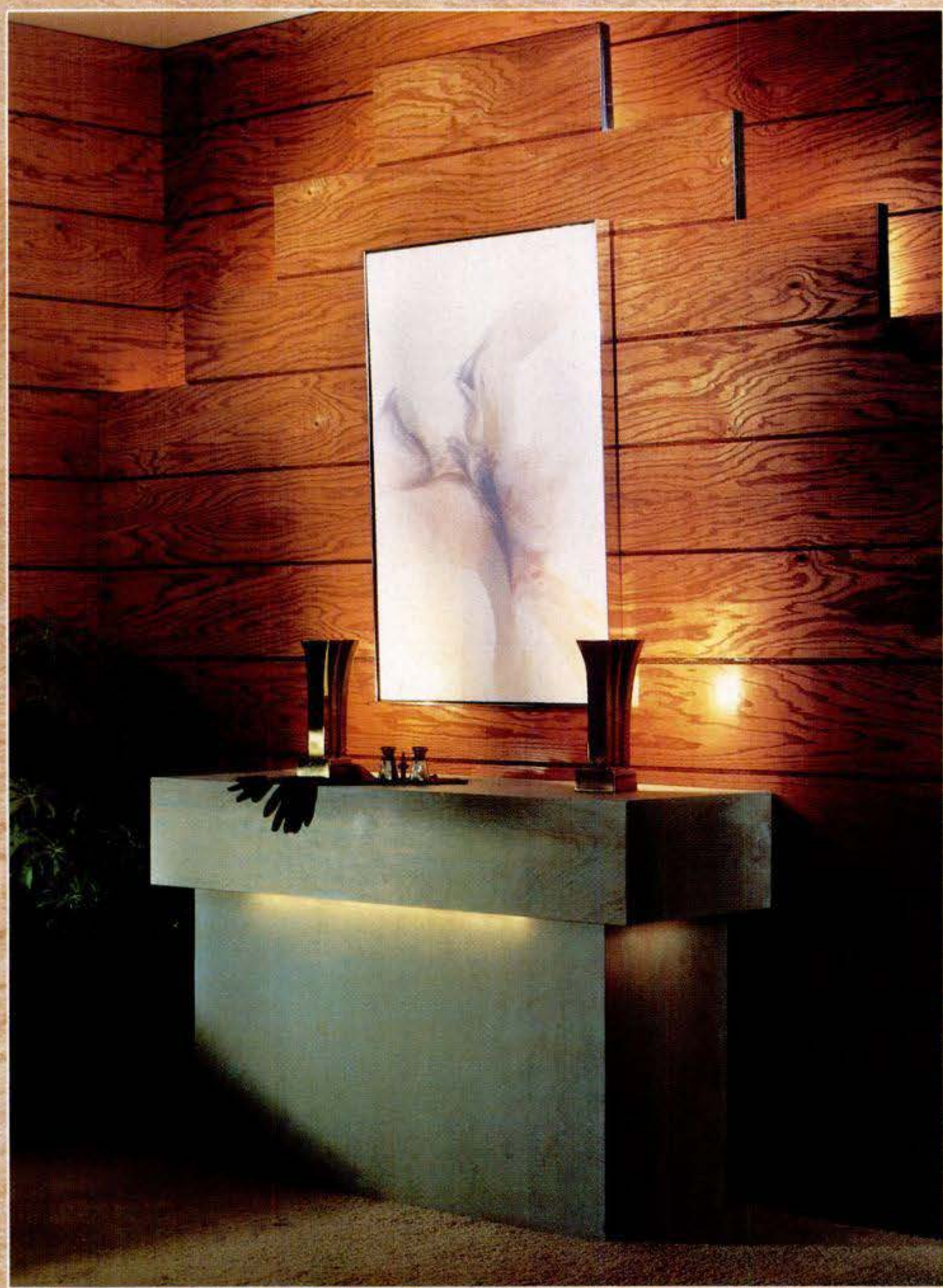

LIGHTED FOYER

WINDOW BOX AND CORNICE

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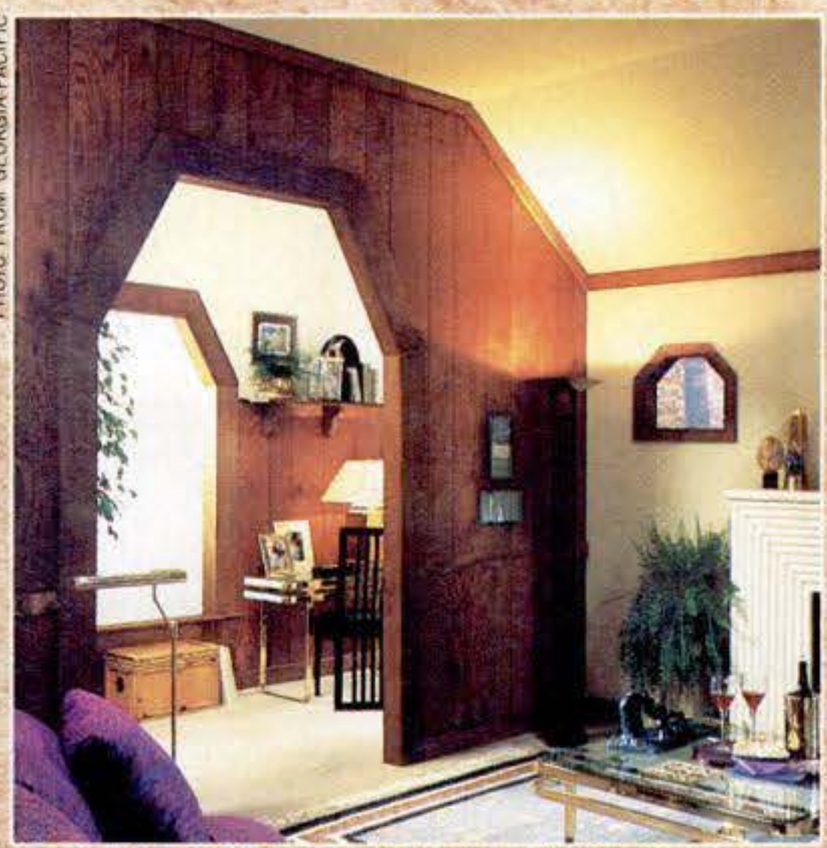
unexpected places

PHOTO FROM GEORGIA-PACIFIC



DIVIDER ARCH

TV PEDESTAL

LAMBREQUIN

COUNTER AND LIGHT VALANCE

Eight paneling projects to get you started (turn page for construction drawings) show range of patterns now available in plywood paneling, from actual or reproduced wood grains to wallpaper-like designs—even a combination of the two, as shown above. Most panels are prefinished, so once you've applied them (with nails or adhesive), the job is done. For purchasing information on any panel shown in these photos, send a business-size self-addressed and stamped envelope to Plywood Paneling Council, 1633 Broadway, New York, N.Y. 10019.

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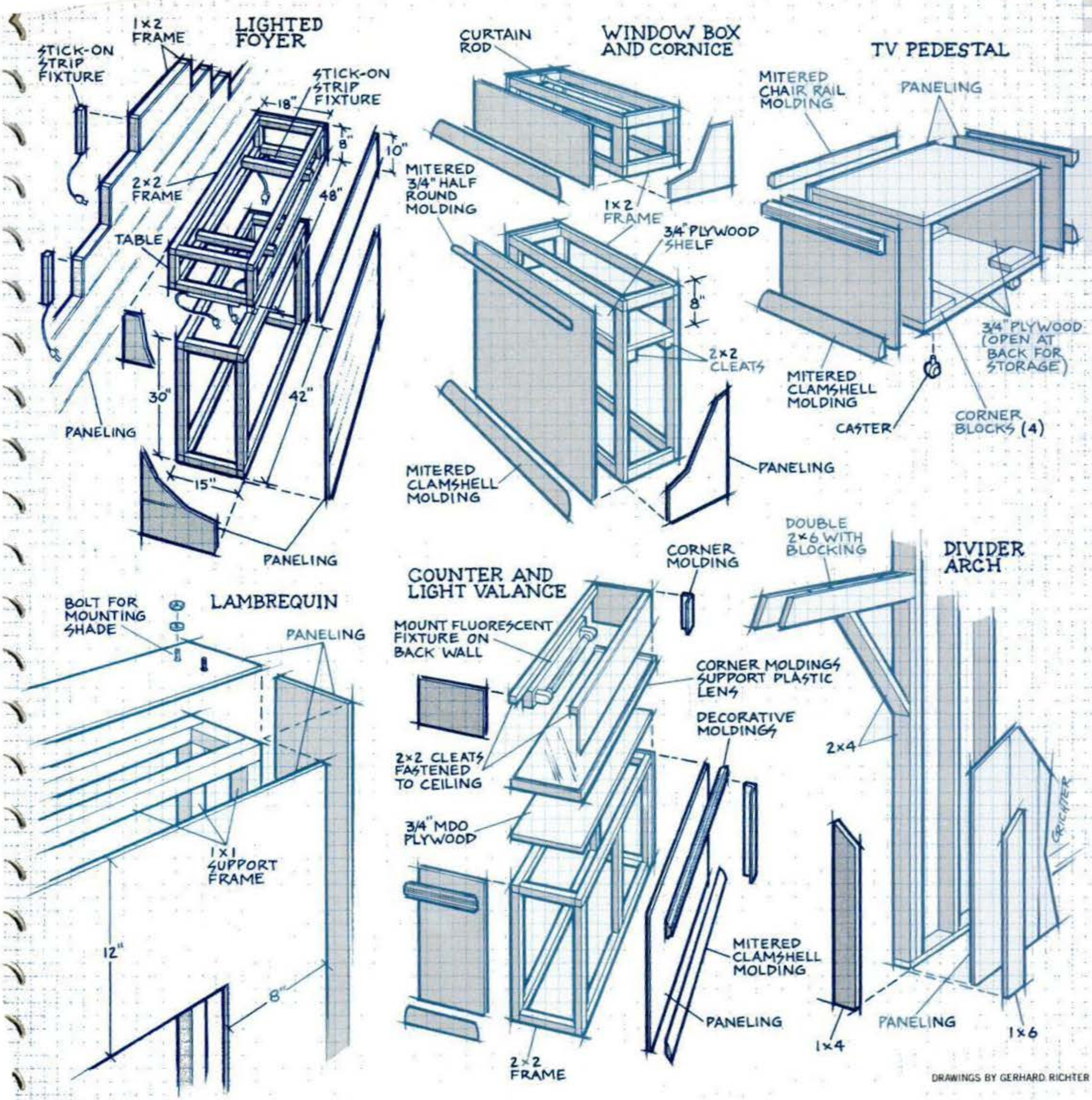

and shot by Photography House. The exception is the divider arch on the previous page, which was created by Georgia-Pacific Corp., featuring its Firelight Forum oak paneling as an accent in the study alcove of an upstairs apartment. The alcove was created by framing a partition and facing both sides with matching paneling. Note that both the arch and window treatment echo the under-roof slant of the ceiling, their openings outlined in pine trim boards finished with an oak stain.

Most of the other projects shown in the photos (and sketched above) are compact enough to be framed in 2×2 lumber. You can join the 2×2s with glue and flathead screws, or by bridging joints with metal plates on the inside. The paneling faces are then cut to cover the frame, and are applied with adhesive or colored nails—or a combination of both. Though usually only a little thicker than ⅛ inch, the paneling will stiffen the frame joints for a sturdy assembly. Most paneling comes in standard four-by-eight-foot sheets. For economical cutting, it's best to lay out (on graph paper) scale drawings of the pieces you'll need.

The lighted foyer achieves its dramatic recessed effect by means of a false wall framed and paneled six inches in front of the actual wall. The oak paneling has evenly spaced grooves (every eight inches) and is applied horizontally to both walls. Don't waste paneling on the lower part of the rear wall, because only the top will show. The "planks" of the front paneling are cut back in steps for a ziggurat effect, and a stick-on shelf light is mounted vertically behind every other step.

More concealed lighting is tucked under the paneling-faced top of the slab-on-cube table. The paneling here is real birch veneer finished with a transparent wipe-on stain. PS

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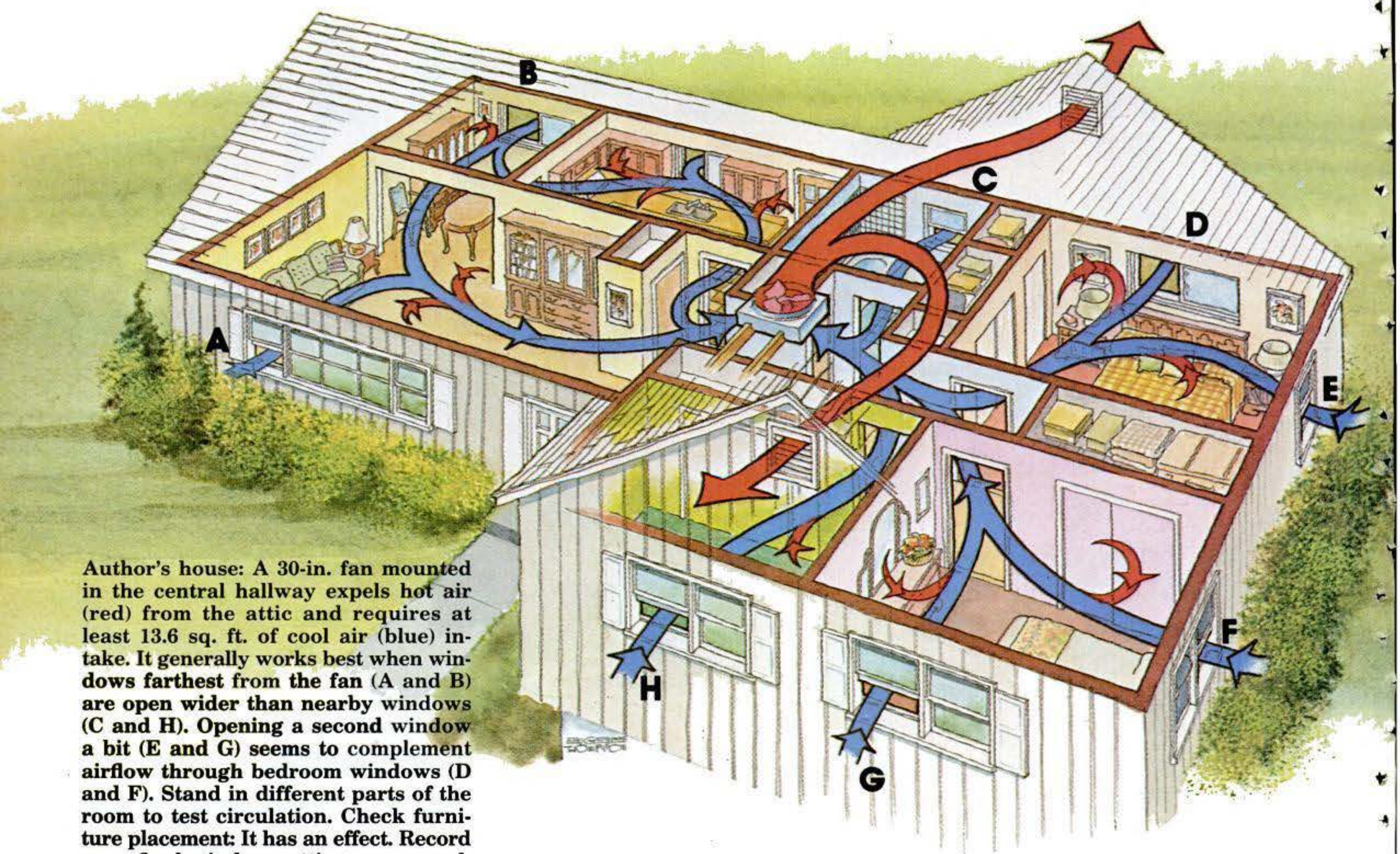
IMPROVE YOUR HOME

Even with air conditioning you need a whole-house fan

This homeowner installed a ceiling exhaust fan and spent last summer fine-tuning his ventilation plan. The result: He never had to turn on his costly central air conditioning until the mercury hit the 90s. Here's how you can slash cooling costs this summer.



Author's house: A 30-in. fan mounted in the central hallway expels hot air (red) from the attic and requires at least 13.6 sq. ft. of cool air (blue) intake. It generally works best when windows farthest from the fan (A and B) are open wider than nearby windows (C and H). Opening a second window a bit (E and G) seems to complement airflow through bedroom windows (D and F). Stand in different parts of the room to test circulation. Check furniture placement: It has an effect. Record your final window settings on a card.

By PHIL McCAFFERTY
Drawings by Eugene Thompson

When I installed central air conditioning a few years ago, I could hardly wait to get rid of my 20-inch window fan. At that time, air conditioning cost less than a dollar a day, and the fan was nothing more than a nuisance.

But by last summer, my air-conditioning costs had nearly quadrupled. I began thinking about that slightly ugly and somewhat noisy fan, remembering how I had managed to cool my house with it on moderately hot days at a negligible operating cost. Right now, similar window fans cost up to $180. But for a little more money I found a better way to cut the cost of keeping cool: a whole-house fan.

I installed a fan in the ceiling of my central hallway, and began trial-and-error experiments with the airflow in my house (see drawing). After I developed a good ventilation scheme, I was able to get along without central air conditioning for all but a few days last summer. Depending on your house and climate, you too may be able to take care of most or all of your cooling needs this way. Whole-house fans are designed for easy installation and operation. Here's how they work:

Ceiling exhaust fans draw air up through the house and push it out through attic gables or eave openings. For the fan to operate properly, you

Continued

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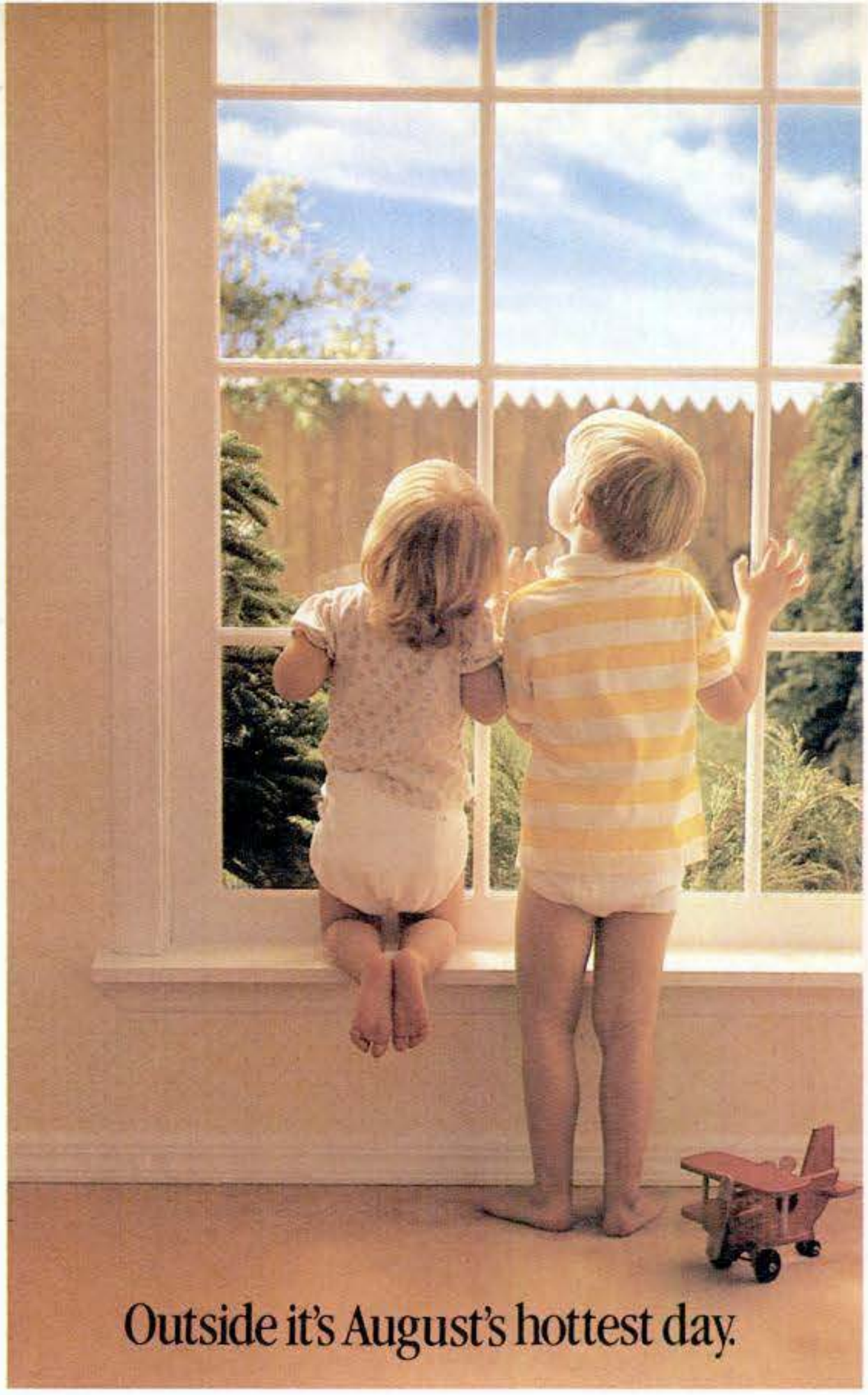

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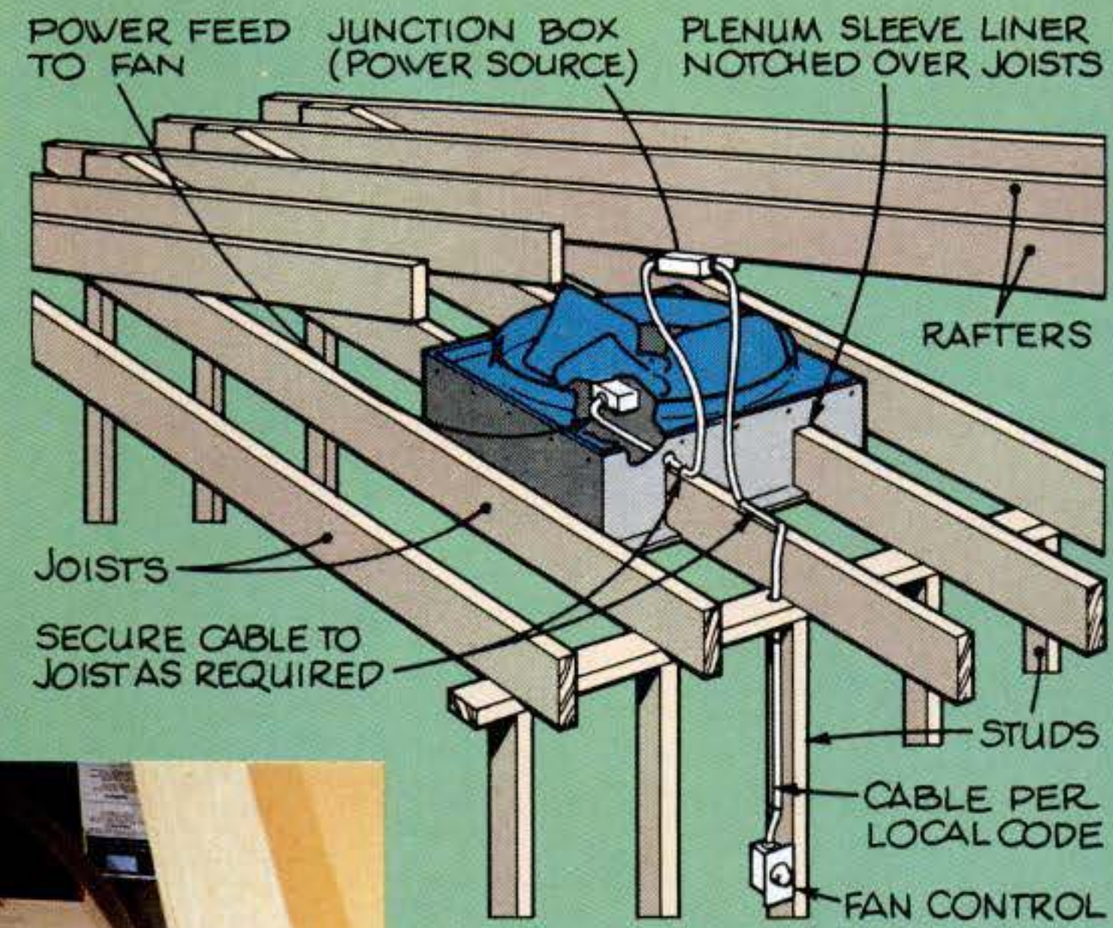

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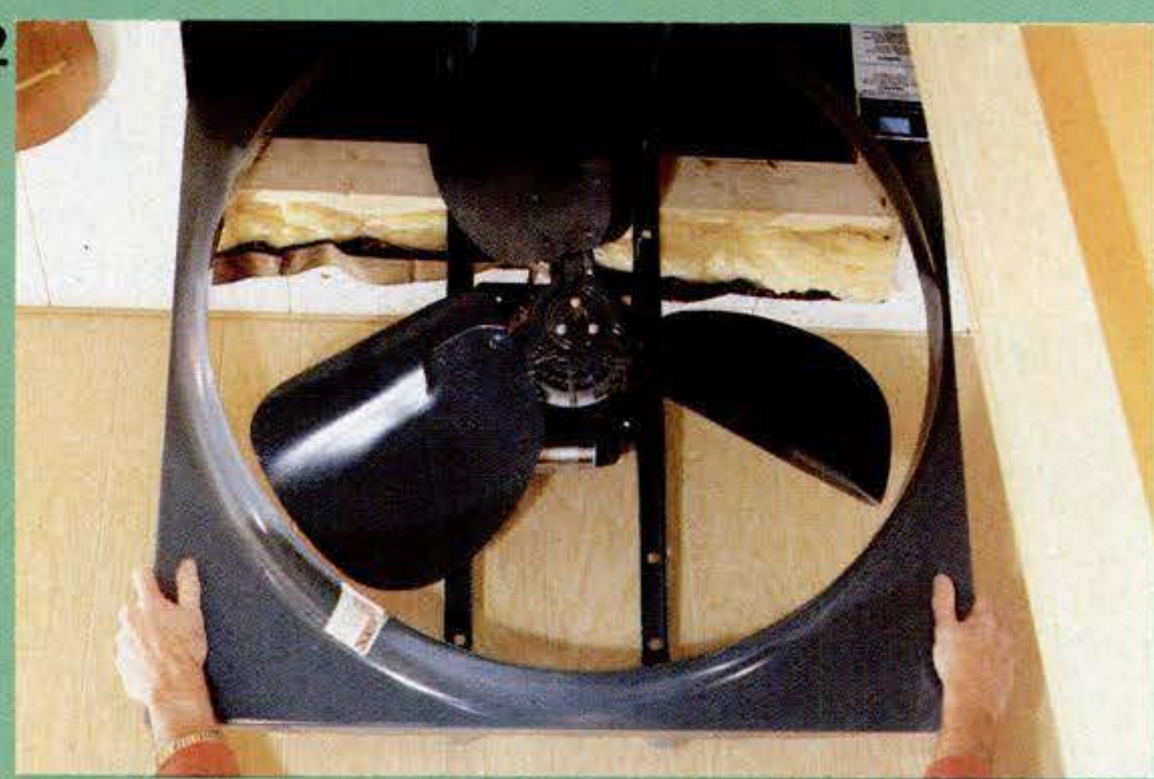

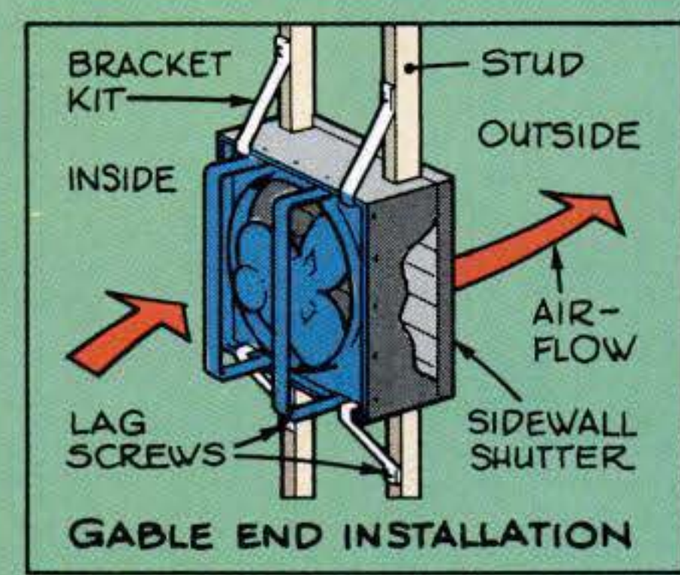

3

PHOTOS BY THE AUTHOR

1) Using a template provided with the fan, cut an opening in the ceiling drywall for the grille. The best place to put the fan is in a central hallway.
2) Most fan models do not require joist cutting. Cut notches in the fan's plenum sleeve, and lift the fan into the ceiling and over ceiling joists (see top drawing). Put the liner around the fan frame. Secure cable to joist, and run it down to controls. If you don't have enough overhead clearance for a ceiling mount, use a vertical gable mount with special brackets (bottom drawing). You'll still need a grille opening in the attic floor.
3) The fan is hidden from view by ceiling shutters. In winter, conceal it with an optional insulated winter cover. None of the fans have blade guards. If the fan is installed where people or animals can get near the blade, add protective devices.

must open some windows, and perhaps exterior doors. Obviously, all hall doors must be ajar. Deciding which windows to open and fine-tuning your plan may take some time, but it will pay off in efficiency and comfort. One word of caution: You may be tempted to open doors and windows in a cool basement, but it's more effective to bring air in through first-floor windows. And if you live in an area where radon is a concern, it's especially important to circulate fresh outside air.

Early in the morning, when the house is cool, close your windows and doors. Keep blinds and shades drawn, to reflect sunlight. It takes time for heat to penetrate the walls and ceilings of your house. Outdoors, it's usually warmest about 3 p.m., but the indoor peak generally occurs between 5 and 6 p.m. Wait until the outside temperature in the shade falls below the indoor temperature, then open your windows and turn on your fan.

As the fan pulls cool air into your house, it dramatically lowers the air temperature in the attic, which can reach 150 degrees F or so without air movement. The fan provides almost instantaneous relief because moving air feels about seven degrees cooler than static air. Makers of whole-house fans say—and I found it to be true—that the fans have limited usefulness when the outdoor temperature rises above 85 degrees F. That's because most people are comfortable with air temperatures of 78 degrees or less.

Last summer I resorted to my central air only on the few days when temperatures reached the 90s and low 100s and humidity was high. Even then, I first ran the fan at full speed to purge hot air from the attic before starting the air conditioner. As soon as the outside temperature dropped in the evening, I switched back to the fan.

It's difficult to compare last summer's cooling costs with those of earlier years, because the weather was unusual in my area—with wide hot-

Text continued on page 82

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A SPA IS A SPA IS A SPA?

A CONSUMER GUIDE

If you've been considering a spa, you're probably already aware of the benefits and pleasures of whirlpool massage. However, not all spas are alike. The true test of any spa is whether it can provide these pleasures conveniently and efficiently. We'd like you to know what to look for when shopping for a spa and show you why the engineers who designed the HOT SPRING SPA® have produced the best spa available today.

1. FULLY WARRANTED MATERIALS AND CONSTRUCTION.

The HOT SPRING SPA is made of the most advanced and durable material of any spa - ROVEL™ **(A)**. Almost all leading manufacturers are turning toward this softly textured non-slip plastic because of its obvious superiority in spa applications. Unlike fiberglass or acrylic surfaces, ROVEL won't peel, blister, crack, or delaminate. As a result, ROVEL is guaranteed to be much more durable than any other spa material. In fact, while most acrylic manufacturers have reduced surface warranties to just one year, HOT SPRING SPA has stood firm with a full five years' coverage. HOT SPRING SPA is the oldest and largest manufacturer of ROVEL spas in the world.

2. CONVENIENCE AND EFFICIENCY.

Most spas have very little thermal insulation, some have none at all! Just how important is insulation? It's the most important feature in private spa ownership! Uninsulated spas will physically not operate in colder climates, making spa use as seasonal as a swimming pool. Further, a marginally insulated spa forces the heater to run continuously, costing you money. Many manufacturers try to compensate for the lack of insulation and their inefficient "air blower" systems by offering gas, 220v., or convertible heaters. While these options are viable in professionally installed, commercial or continuous use applications, they represent an unsafe, inconvenient, and costly alternative for residential use. The HOT SPRING SPA is filled SOLID with 130 lbs. of polyurethane foam insulation **(B)** and includes a 3½" thick insulating cover as standard equipment **(C)**. This heavy insulation makes it economical to keep the 110v. HOT SPRING SPA heated to your desired temperature 24 hours a day, regardless of location. You can use your HOT SPRING SPA at any time, day or night, in ANY climate, and for just pennies.

3. HYDROTHERAPY JETS.

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4. WATER CHEMISTRY AND FILTRATION.

Look for a large water capacity when shopping for a spa. Units that contain less than 180 gallons make it difficult to maintain proper water chemistry and require frequent draining. In addition, a larger capacity aids in heat retention. The HOT SPRING SPA contains over 325 gallons of water. Unlike many portables that have overlooked the value of good filtration, the HOT SPRING SPA features a huge 45 square foot filter **(H)**. Because of its size, it requires attention only 2 to 3 times per year. Its top loading design allows you to inspect, remove and clean it without draining the spa.

5. SEATING AND LIGHTING.

The HOT SPRING SPA features a split level seating ring, built deep for comfortable reclining and total immersion **(I)**. The barrier-free design eliminates the cramped, confined feeling of bucket seats, and allows you to move easily from fixed jets to moving jets or parts in between. The wide resting rim **(J)** provides an ideal perch for cooling off, or a safety bench for children. The HOT SPRING SPA also features an oversized underwater light with dimmer **(K)**. Colored bulbs can be interchanged quickly and safely to create different effects.

6. NO INSTALLATION.

Simplicity of installation should be checked. An in-ground spa is the most difficult, requiring backyard excavation, building permits and an expensive installation crew. Permanently wired 220v., and gas units are not much simpler, and completely eliminate the advantage of portability. The HOT SPRING SPA avoids these problems by requiring only common household current to operate (110v. dedicated 20 amp.) **(L)**. Just fill it up and plug it in. Its unique "treated grid" system requires no specific foundation for set-up and, as a portable appliance, you can take the HOT SPRING SPA with you when you move.

7. LISTED BY UNDERWRITERS LABORATORIES.

The HOT SPRING SPA is completely listed by Underwriters Laboratories, the recognized experts in testing for safety. The importance of correct and safe electrical design should not be overlooked. Check for the U.L. Mark on the outside of any spa you're considering - you'll see it on the HOT SPRING SPA.

We are proud of the quality features and performance we build into every HOT SPRING SPA. Each HOT SPRING SPA is an integrated design whose form follows function - the result of 10 years' evolution toward an ideal. So, before you buy any spa by any other name, see and *test* the HOT SPRING SPA. It's not the same.

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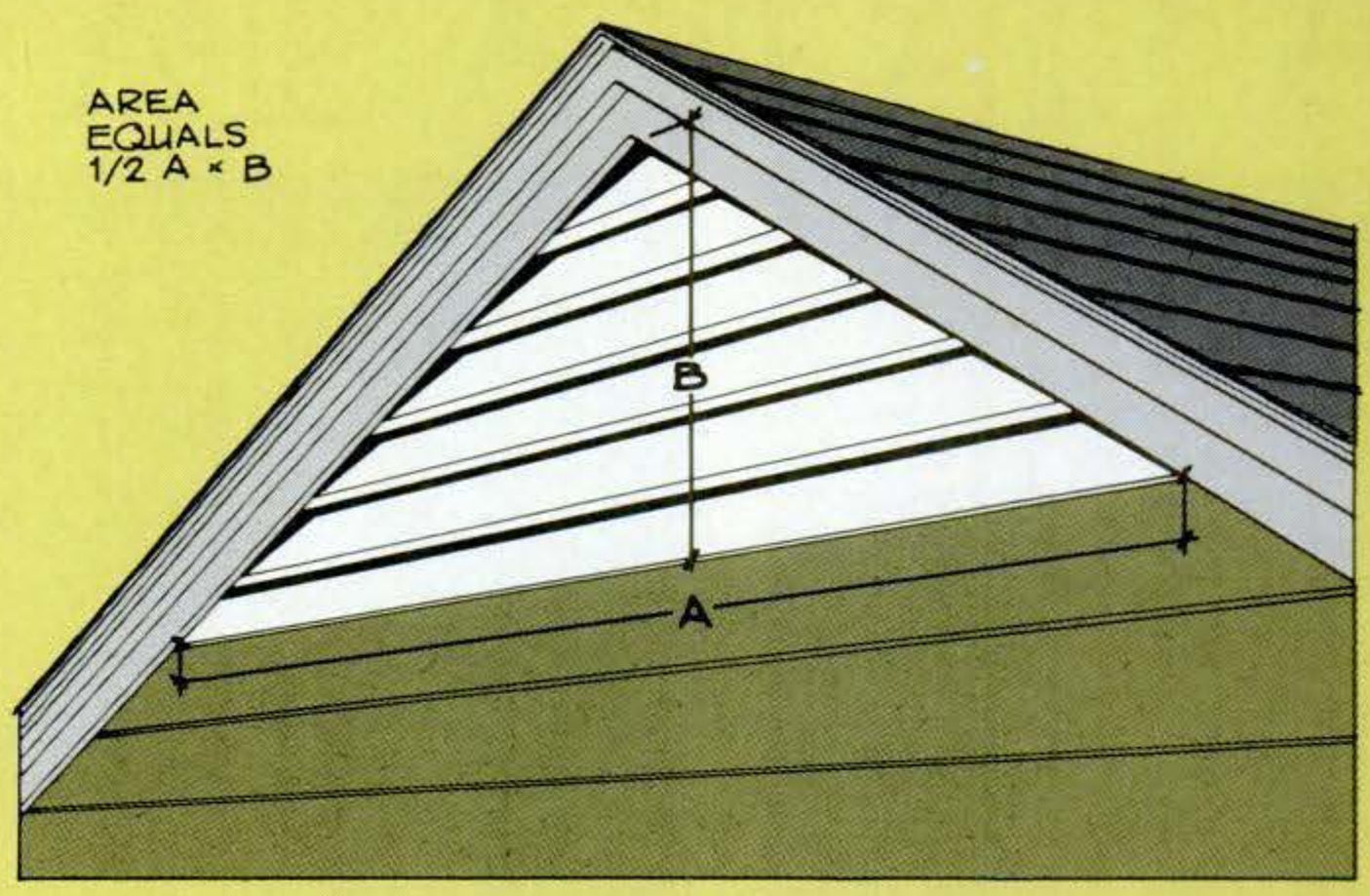
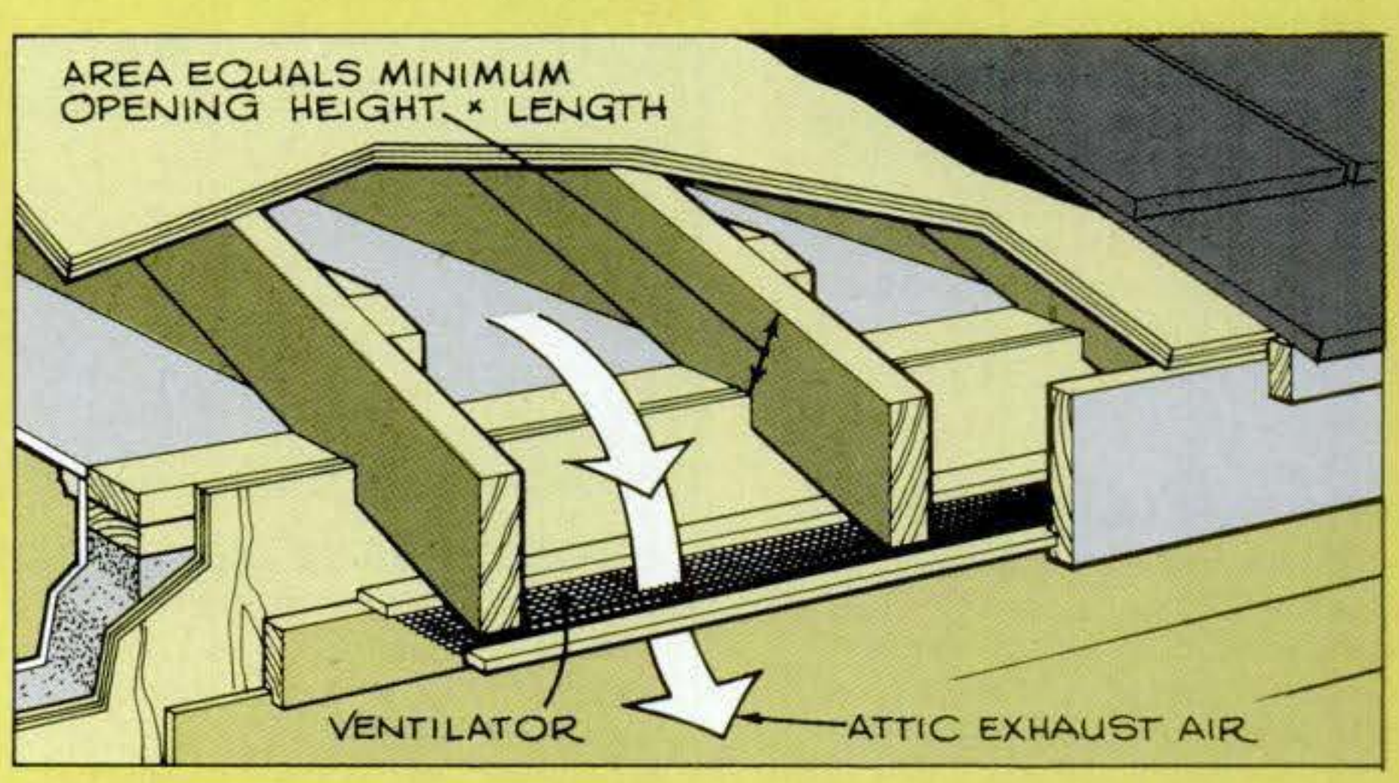
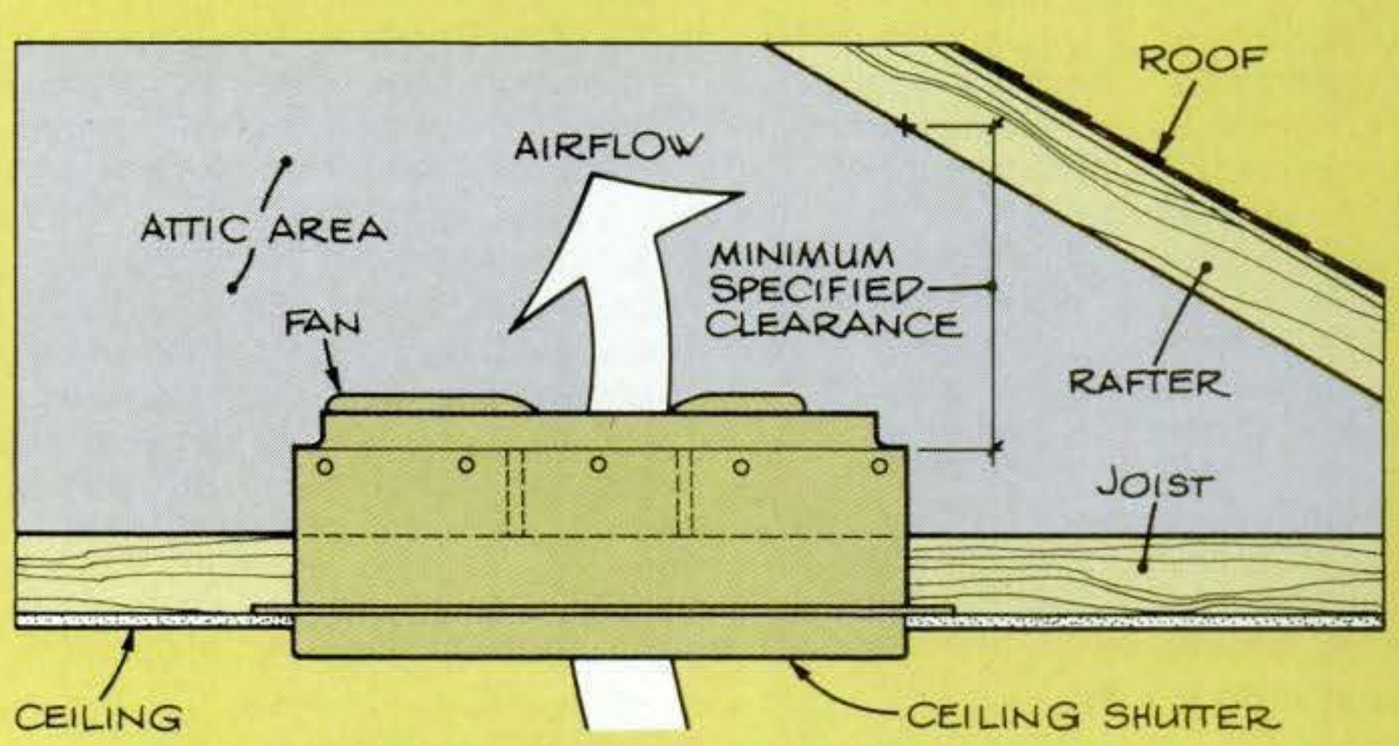


LOUVER AREA



EAVE OPENINGS



REQUIRED CLEARANCE

The specifications for each fan call for a minimum overhead exhaust clearance to avoid back pressure that will reduce efficiency and increase noise. Before you buy a fan, determine where you'll put it, and make sure there is adequate clearance (bottom drawing). If not, you'll have to reposition the fan or use a vertical gable mount. Each maker also specifies a minimum square footage of attic exhaust opening. Measure the area of your louvers (top drawing) or eave openings (middle drawing). You may have to add another attic opening. Most manufacturers offer louvered panels.

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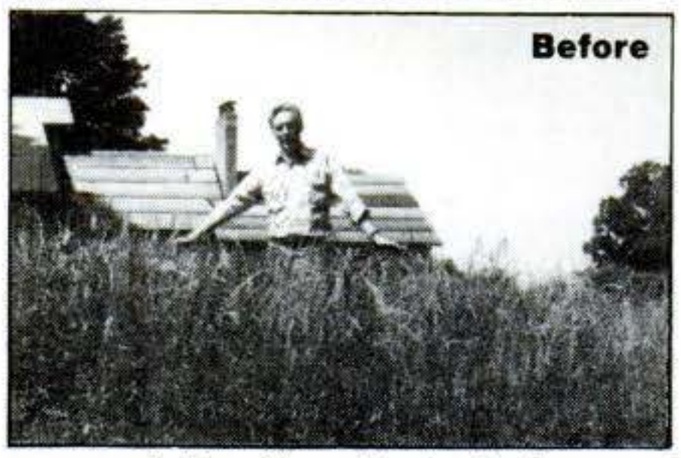

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Whole-house fan

Continued

cool swings and a shorter-than-normal hot spell. But I do know that when I run the ceiling fan, I am paying for only ⅓ horsepower. The air conditioner, combined with its fan and the furnace blower, is rated at three horsepower. So the fan's operating cost is about 1/10 that of air conditioning. I expect to recover its cost in power savings within a couple of years.

My 30-inch variable-speed fan from Sears cost about $280. Smaller whole-house fans are available for as little as $100. The fan blades are direct- or belt-driven, with diameters of 20 to 42 inches. The motors are about ¼ to ¾ hp. Some are single-speed; others have two speeds or variable speeds. The fans can move anywhere from 3,000 to 17,000 cubic feet of air per minute.

The most popular fans are 24- and 30-inch units, used in 1,200- and 1,700-square-foot houses, respectively. Airflow for these fans is 3,600 to 5,700 cubic feet per minute. Check fan specifications to find out which size you'll need. When in doubt, choose the larger, higher-volume fan.

You can use a whole-house fan in a two-story house, too, but you should choose a fan based on the total square footage of both floors. Ideally, the fan should be centrally located in the upstairs hallway. One maker has this two-story tip: Keep the upstairs windows closed until evening, pulling all the air through the lower windows. When you retire, close the downstairs windows and open the others.

You may want to add accessories to your fan. I spent about $60 for a thermostat, an insulated winter cover, and a "firestat"—a safety device that shuts off the fan at 204 degrees F. In a fire, a running fan could act like a blast furnace. The firestat also has a kill switch to shut down the fan when you are working around it. Never work near a powered fan.

My unit also has an automatic temperature control that shuts down the fan when the house cools to a selected temperature, but the fan must be manually started. The reason? To make you remember to open enough doors and windows to provide the minimum air intake specified for your fan. If you don't furnish an adequate air supply, your fan may draw gases from the flues of fireplaces, furnaces, or water heaters inside your house. PS

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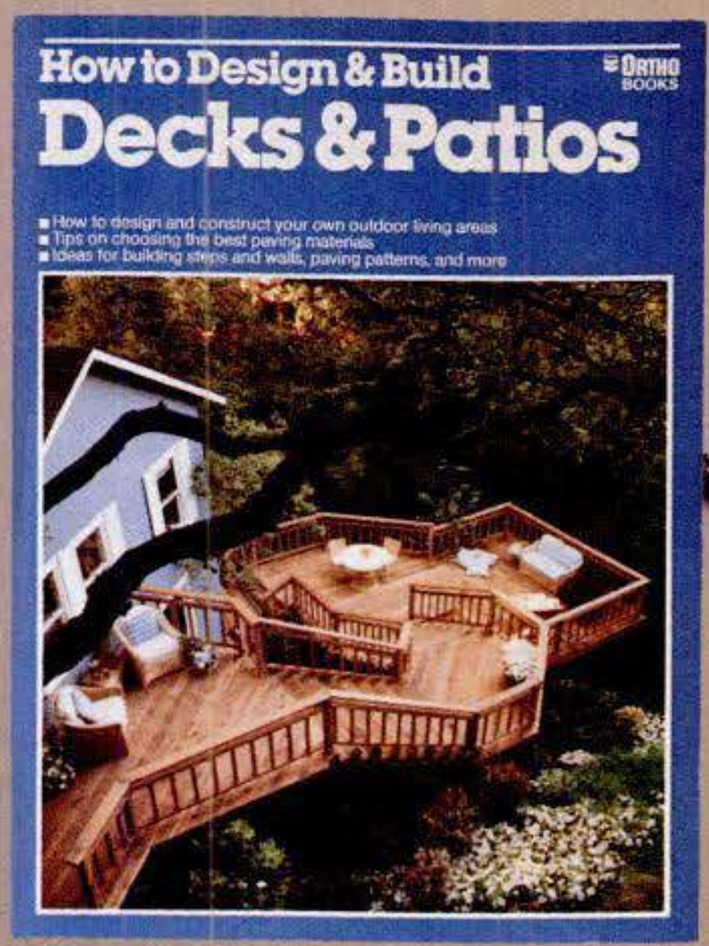

Remodeling woes?
Don't get mad, get arbitration

Joseph Connors and his wife were tired of the vinyl floor in their house, so they hired a Dallas company to replace it with wood parquet. Installed over a cement slab, the new floor covered about 600 square feet in the kitchen, dining area, and game room. "When the workmen left that day, it looked beautiful," Connors remembers.

But the charm wore off when, after three months, the floor began buckling. "You had to watch where you walked," Connors recalls. "What I thought was something I was going to enjoy turned out to be a nightmare."

Connors called the vice president of the remodeling company, who "told me he'd give me a good price on another floor." After a series of telephone calls, unsuccessful attempts by the company to repair the floor, and a sanding job that marred it, Connors opted for arbitration.

The company that installed Connors' floor was a member of Customer Care, a program set up by the Dallas Better Business Bureau. Companies that belong to Customer Care—renamed Remodelcare when it expanded to other cities—have pledged to enter binding arbitration if a complaint cannot be settled by negotiation. Remodelcare's sponsors include the National Association of the Remodeling Industry—a trade group for 3,800 contractors. If you need help in a dispute with a remodeling contractor, call your local BBB or NARI chapter for information.

The Dallas program, which now has about 2,500 members in a range of industries, handled about 3,000 complaints in 1986. Only five to 10 percent of the cases ever reach arbitration; the rest are resolved through mediation.

In Dallas, remodelers and manufacturers pay $75 a year (plus BBB membership dues) to cover Customer Care fees. Other Remodelcare programs set their own participation charges. The arbitrators are community volunteers who can call on expert witnesses for assistance.

Connors' arbitration hearing took about an hour. Within 10 days, he received a letter saying he was entitled to a full refund—about $3,900. The remodeler was surprised by the decision; he claimed that the fault lay with the contractor who built the house and omitted a moisture barrier beneath the concrete slab.

Overall, 40 to 45 percent of the arbitration decisions in Dallas have favored customers. Companies have won 35 to 40 percent of the cases. The remainder have been split decisions, giving partial findings to each party.

Win or lose, most companies plan to re-enroll in Customer Care and Remodelcare. "I would rather sit down and discuss it with the person than go to court," says William Keller, general manager and vice president of Pacesetter Corp., which does $70 million worth of business in windows and doors a year. "The attorneys get real fat on those deals that no one wins."

Customer Care settled a dispute between Pacesetter and William Luck, a customer who ordered storm windows for the inside of his mobile home. A mediator intervened, and the company reinstalled the windows to Luck's satisfaction. The whole process took just six weeks.

Luck and Connors are pleased with the assistance they received. "I was beginning to think that I was just going to have to take the loss," Connors says. "It really brought back my faith in justice."—*Dawn Stover*

DECK OUT YOUR YARD.

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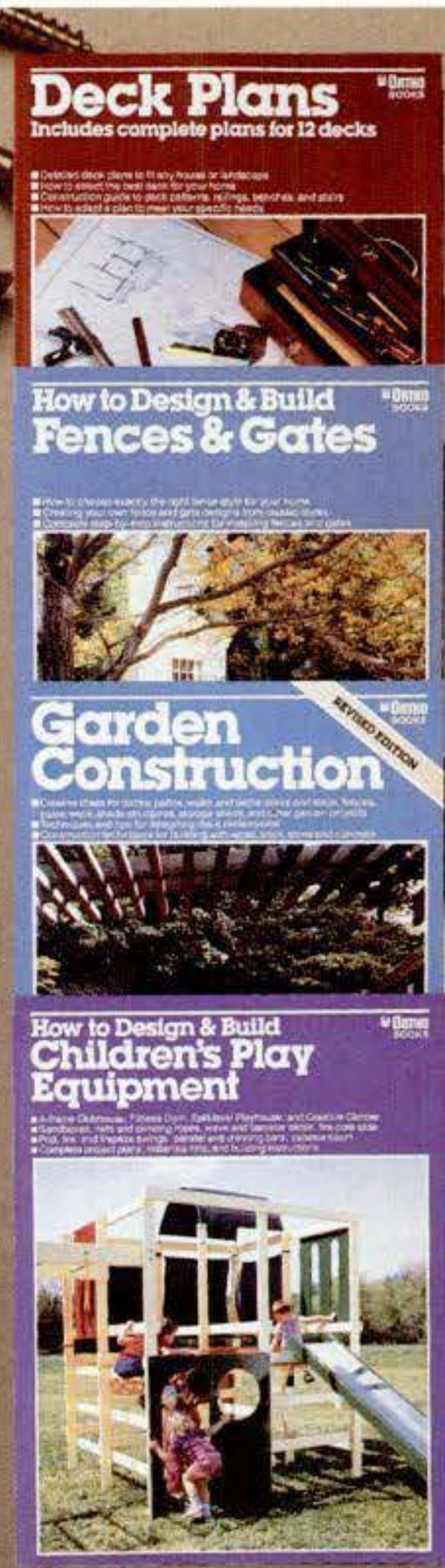


Chevron

ORTHO INFORMATION SERVICES

6 steps to keep garage doors rolling

Whether electrical or manual, the opening system for your garage door is so essential that it's usually taken for granted—until something fouls it up and the door won't open. Talk to garage-door installers in your area, and you'll learn that virtually all problems can be traced to a lack of lubrication. It's just one of those little chores we all overlook—even though replacing a garage-door system can be a major hassle and expense. (Could it be the prospect of profitable replacements that prompts most manufacturers of the systems and doors to omit lubrication tips from owner's manuals?)

Metal garage-door components are especially vulnerable, since they're exposed to both the grime and corrosiveness of car exhaust, in addition to weather and moisture. Happily, maintenance is simple. A light oil or other lubricant applied to springs, roller, hinges, bearing units, and chain and trolley assemblies is usually all that's needed. Contacting parts will wear because of constant friction, but a film of oil between surfaces keeps deterioration to a minimum. It's a classic case of preventive maintenance.

Don't expect a penetrant to do the lubricating, though. Such a product will cut through a buildup of dirt and grime, but it leaves only a negligible surface film. *Following* a penetrant coating with a lubricant coating can be effective, however. Better still, look for a combination penetrant/lubricant, and lubricants containing Teflon fluorocarbon resin. (Tri-Flow is one brand.) These products are cleaner to work with than grease; they resist washing off, repel dirt, and leave a long-lasting protective coating.

Here are six easy steps to garage-door maintenance:

1. With a light oil or aerosol spray tube, treat the springs over the top of the door. These springs are the quickest part of the system to wear out, and they cost up to $130 to replace. Since the springs rub against metal every time you move your door, proper lubrication is essential.

2. Lubricate the door hinges. This is where a penetrant/lubricant is ideal —it gets into hard-to-reach cracks.

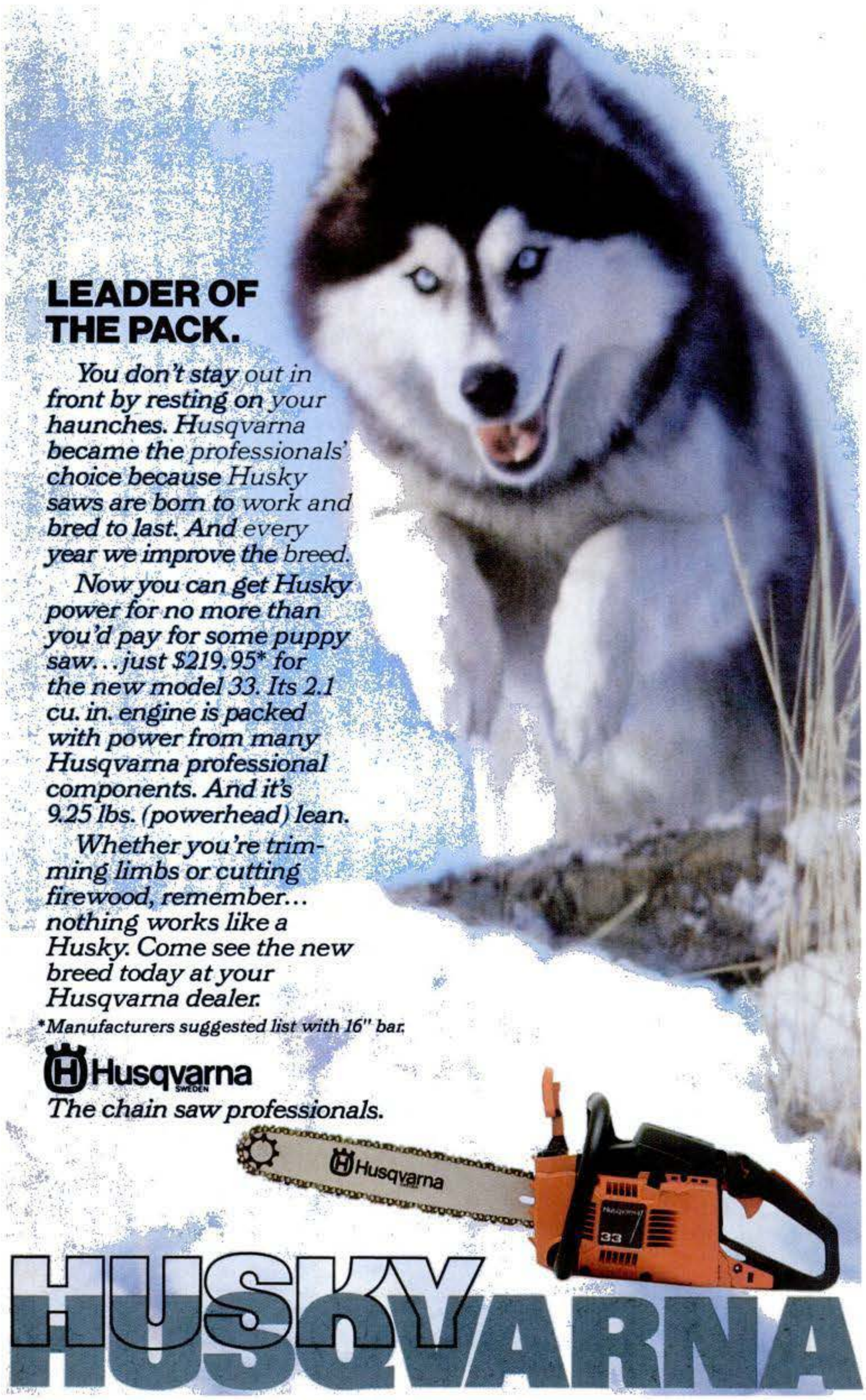
3. Lubricate the chain. This is important because the chain travels along the trolley assembly each time the garage door opens or closes. Teflon-based lubricants are best here; they're less likely to attract dirt and grime.

4. Lubricate the bearing assemblies inside the rollers. This simple operation may spare the $500 to $2,000 cost of a replacement door.

5. Lubricate the rollers themselves. On the average garage door they'll travel about three miles a year. Problems that often develop with garage-door rollers include closing at non-uniform speeds and sticking. Either problem could ruin a door system.

6. Finally, lubricate the trolley assembly, another part of the system where metals are in constant contact. A film of oil can reduce wear significantly and avoid the replacement cost of the trolley and automatic opener, at anywhere from $200 to $300.

But remember, one treatment will not last forever. It's important to lubricate regularly as well as thoroughly. For a house near the ocean, once a month is not too often. For homes in drier climates, once every four months should keep your garage doors right on track.—*Al Lees*



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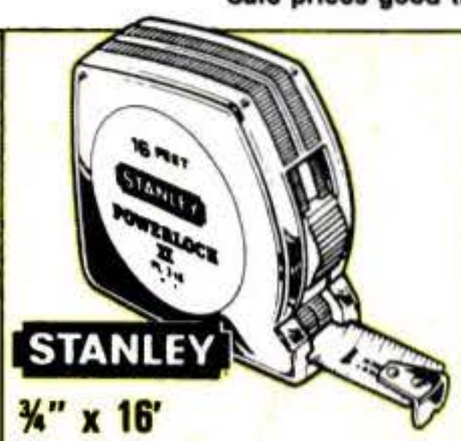

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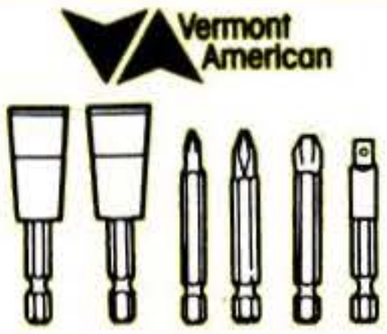

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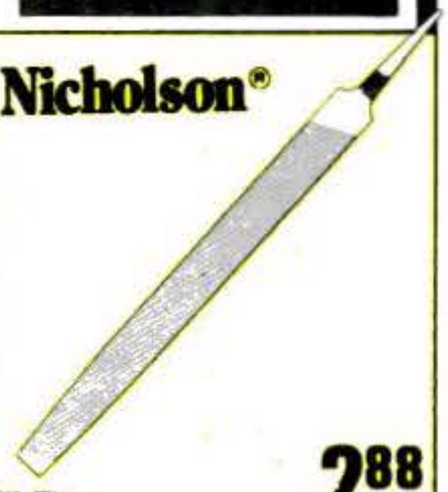

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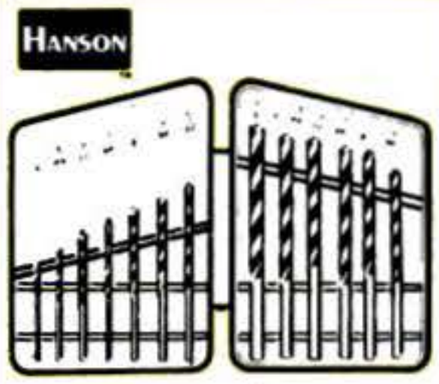

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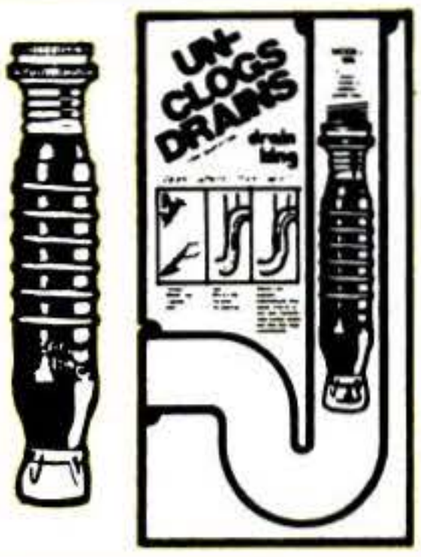

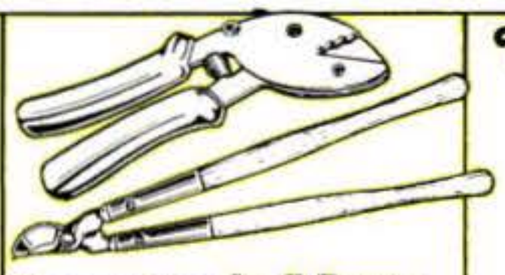

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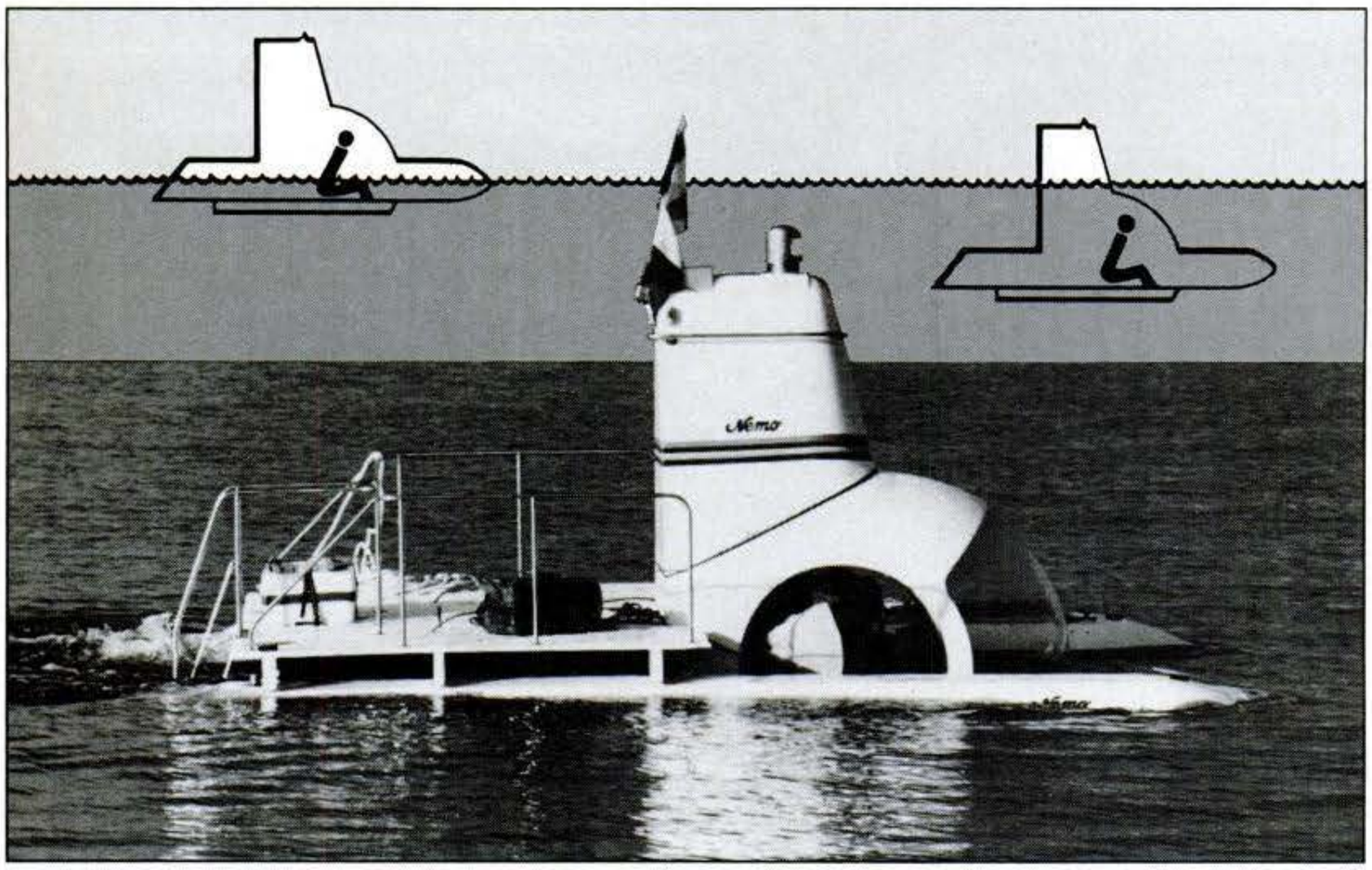
What's New
PRODUCTS/TECHNOLOGY

BY DAWN STOVER

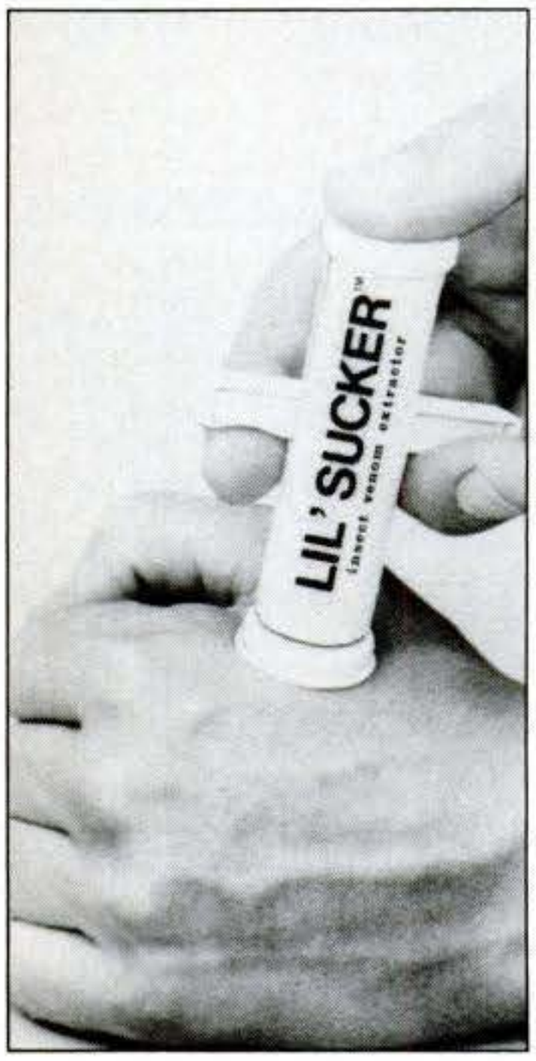


Blink counter

The Air Force is testing an eye-blink detector, mounted on the nose part of an oxygen mask, that uses infrared light to monitor blink rate. G-forces during flight maneuvers can cut the brain's blood and oxygen supplies, and pilots get a fixed stare just before passing out.

French sub

In clear water, you can see up to 100 ft. away and 70 ft. down in this semi-submersible. Nemo sinks a few feet below the surface when its two 16-ft. hulls are partially filled with water. A conning tower supplies fresh air. IDC, 9 Pl. Kleber, 67000 Strasbourg, France. $38,000.



Aero truck

TX450's drag coefficient is 0.36—less than half that of most trucks. It uses a 160-hp turbocharged diesel engine, continuously variable transmission, rear-wheel steering, and rear-view video camera. Leyland Vehicles, Lancaster House, Leyland, Preston PR5 1SN, England.

Sting relief

Bitten by a bee, wasp, spider, mosquito, or scorpion? This vacuum pump extracts venom before it spreads through your body, causing a painful —or even fatal—reaction. Lil' Sucker ($6) draws poison out through the hole it entered. Tecnu Enterprises, 828 E. First Ave., Albany, Ore. 97321.

Roomy pickup

Isuzu's 1987 Spacecab P'UP pickups have extra storage capacity. There's even room for side-mounted jump seats. The LS luxury/sport edition comes with two-tone paint, body-color grille, and fender flares. A pop-out sun roof is standard on LS Spacecabs. From $10,019.

Flying wing

Lockheed-Georgia Co.'s concept would use laminar flow control to improve aerodynamic efficiency. Perforations or slots on the wing's leading edge remove a turbulent layer of air that creates drag. The plane would be able to carry 150,000 lbs. over 6,500 nautical miles.

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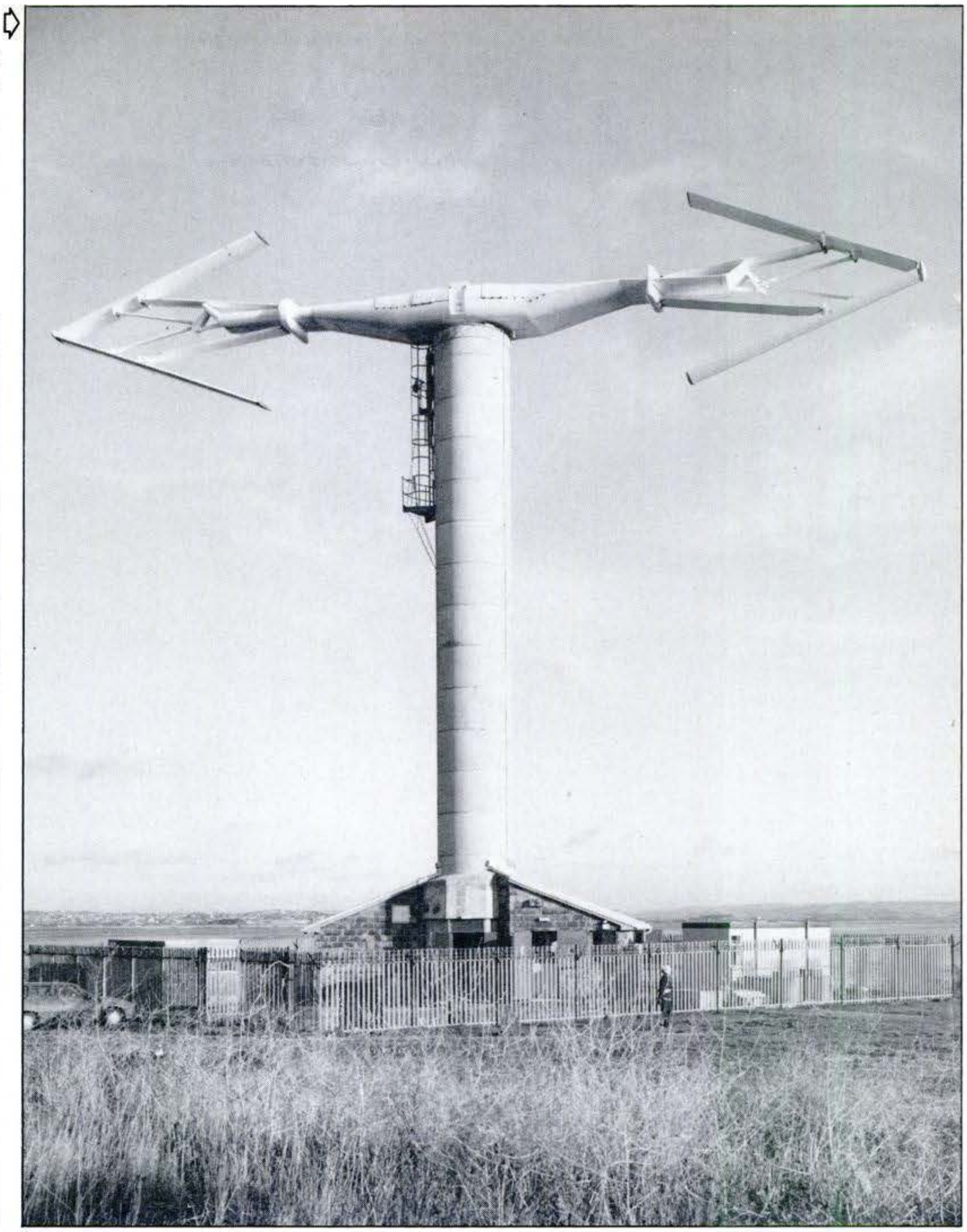
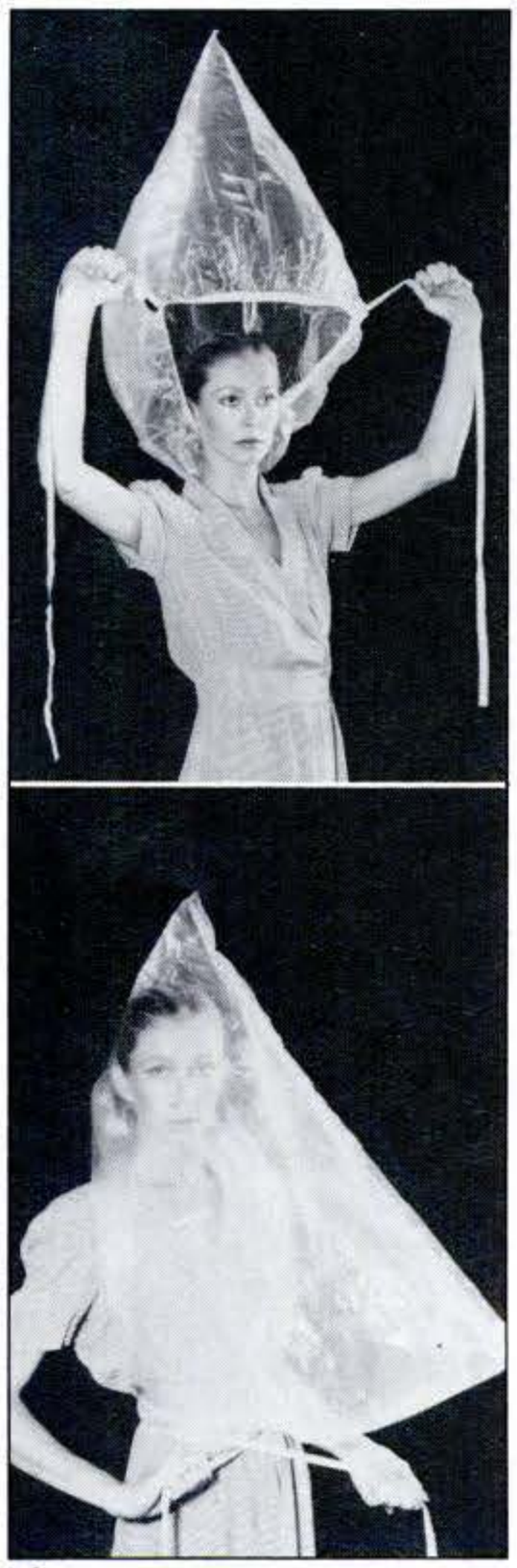
Arrowhead blades

The largest-yet vertical-axis windmill pumps 130 kW into the electricity grid at Camarthen Bay in Wales. The rotor is omnidirectional, so no steering mechanism is needed [PS, April '86]. Vertical Axis Wind Turbines, 1 St. Albans Rd., Hemel Hempstead, Herts HP2 4TA, England.



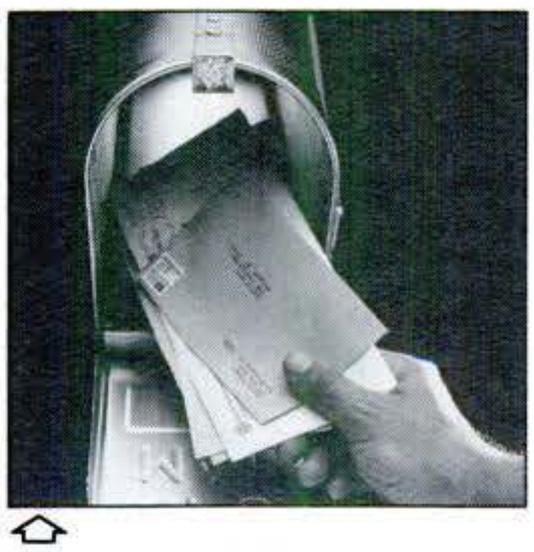


Smoke hood

Escape a smoke-filled building without succumbing to fumes. Don a Smoke Shelter ($15), and tie it around your waist, trapping a 10-min. air supply. The bag withstands heat up to 350° F, says Ventco Medical Co. (721 Walker Ave., Montreal, Canada H4C 2H5).

Automated garage

This valet won't play bumper cars with your auto. Lock your doors and insert a coded card into a scanner, then walk away. A computer-controlled dolly shuttles the car to a parking stall along a hoistway shaft. High Tech Parking Systems, 548 Cabot St., Beverly, Mass. 01915.



Mailbox sensor

When your letters arrive, Mail Call ($90) sounds an alarm and flashes a light. A photocell sensor in the mailbox activates a 9-V transmitter that sends a signal to a receiver in your home. Sporting Edge Catalog, 22121 Crystal Creek Blvd. S.E., Bothell, Wash. 98021.

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What's New in Recreation

BY STUART F. BROWN

Cordless winch

Far from the nearest electrical outlet, there's 1,000 lbs. of pulling power available with the Porta-Power winch. A high-output rechargeable battery provides the juice, according to Powerwinch (810 Union Ave., Bridgeport, Conn. 06607). Price: $373, with charger.

Road sculpture

Take a three-cylinder fuel-injection 750-cc engine, and lay it over sideways. Add shaft drive, triple disc brakes, and a taut suspension system. The result is the $5,950 K75S, an elegant and sure-footed road-burner from BMW of North America (Montvale, N.J. 07645).

Rain brakes

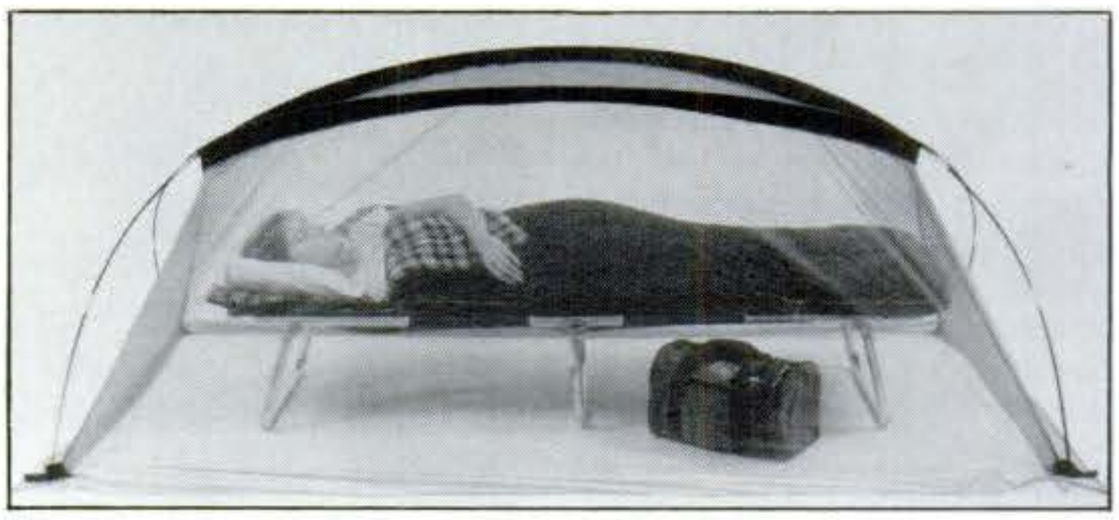
Everyone knows that caliper-type bicycle brakes are pretty useless when the wheels get wet. Not so these drum brakes, which have seals that keep water and dirt from the internal friction surfaces, says Fichtel & Sachs AG (8720 Schweinfurt, West Germany).

Hot-rod life vest

Offering maximum protection to tournament bass fisherman and other performance boaters, Skeeter's life vest is UL-approved for water impact at more than 100 mph. Leg straps help keep the $85 vest in place. It's made by Skeeter, Box 230, Kilgore, Texas 75662.

Planing catamaran

Twin planing hulls with flat bottoms at the stern make the Planecat both fast and roomy enough to sleep four adults, says the manufacturer (Planecat Corp., 9656 North River Rd., Algonac, Mich. 48001). An 18-footer costs $6,995 with dual rudders and centerboards.



Don't get bugged

Two people sleeping on the ground or one person lying on a cot can pass the night mosquito-free, says the maker of the TropicScreen net tent. Fiberglass poles support the fine-mesh net. Price: $40 from Epco Design (900 First Ave. S. #303, Seattle, Wash. 98134).

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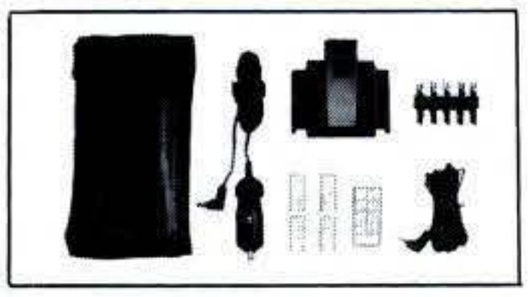

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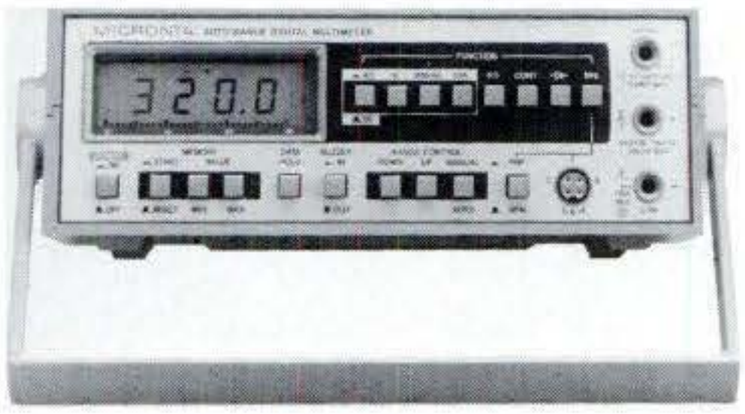

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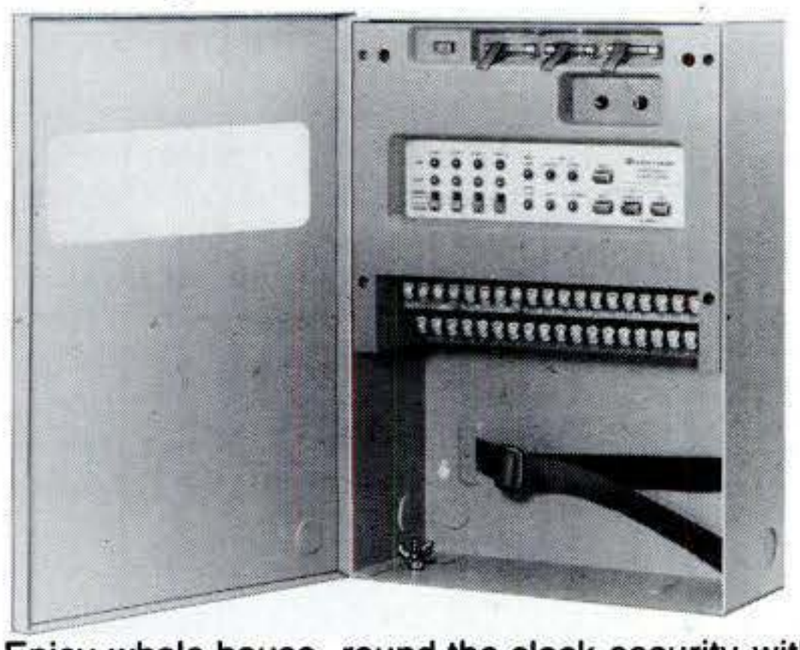

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What's New in Electronics

BY DAWN STOVER

PC clone

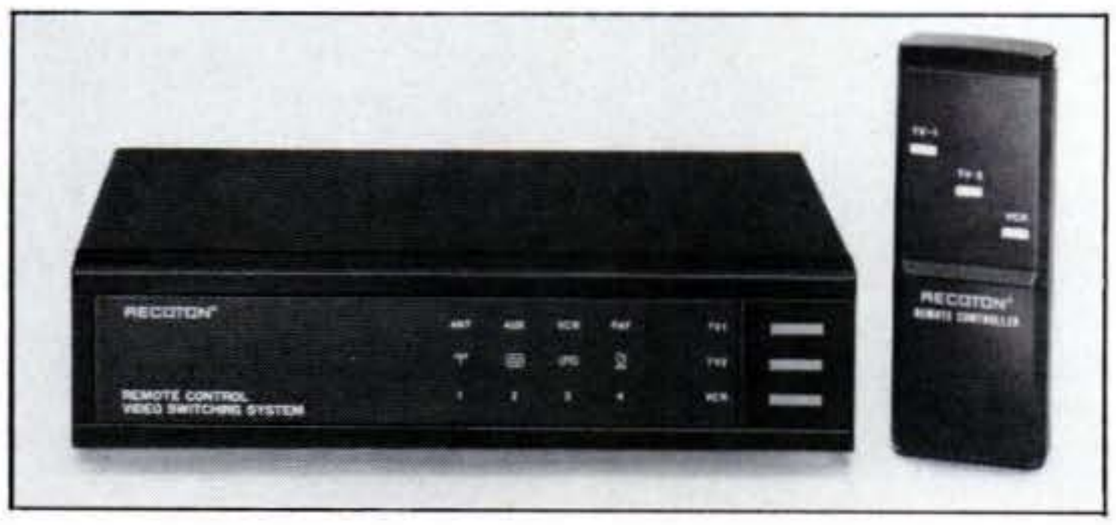
Commodore's $999 PC10 is IBM PC-compatible. The computer includes a 360K double-sided, double-density floppy-disk drive and 512K RAM (expandable to 640K). A $1,199 version has two disk drives and 640K RAM. Both machines can be fitted with a hard disk.

Fast talker

Now you can listen to tape recordings of interviews or meetings in half the time it took to record the sessions. General Electric's Fastrac ($110) lets you increase playback speed. You can lower pitch at the same time, so voices aren't distorted.

Personal copier

Say goodbye to writer's cramp and long lines at the photocopy center. Instead, take notes with Sharp's portable Z-HC1 Handy Copier. Scan a page with the copy wand, and the printer duplicates the information on a 3-in.-wide scroll of thermal paper. The copier costs $190.



Video switcher

Route programs to two TVs and your VCR without leaving your chair. The V640 infrared remote-control switching system has four inputs, so you can choose from antenna, satellite, VCR, and cable entertainment. Recoton Corp., 46-23 Crane St., Long Island City, N.Y. 11101; $150.

Car guard

You can set shock and motion sensors on Kenwood's KPC-70 to detect false alarms. In one mode, the 100-dB siren isn't fully activated unless a car is attacked twice within 10 sec. An event monitor on the $549 remote-control system tells you when the car was disturbed.

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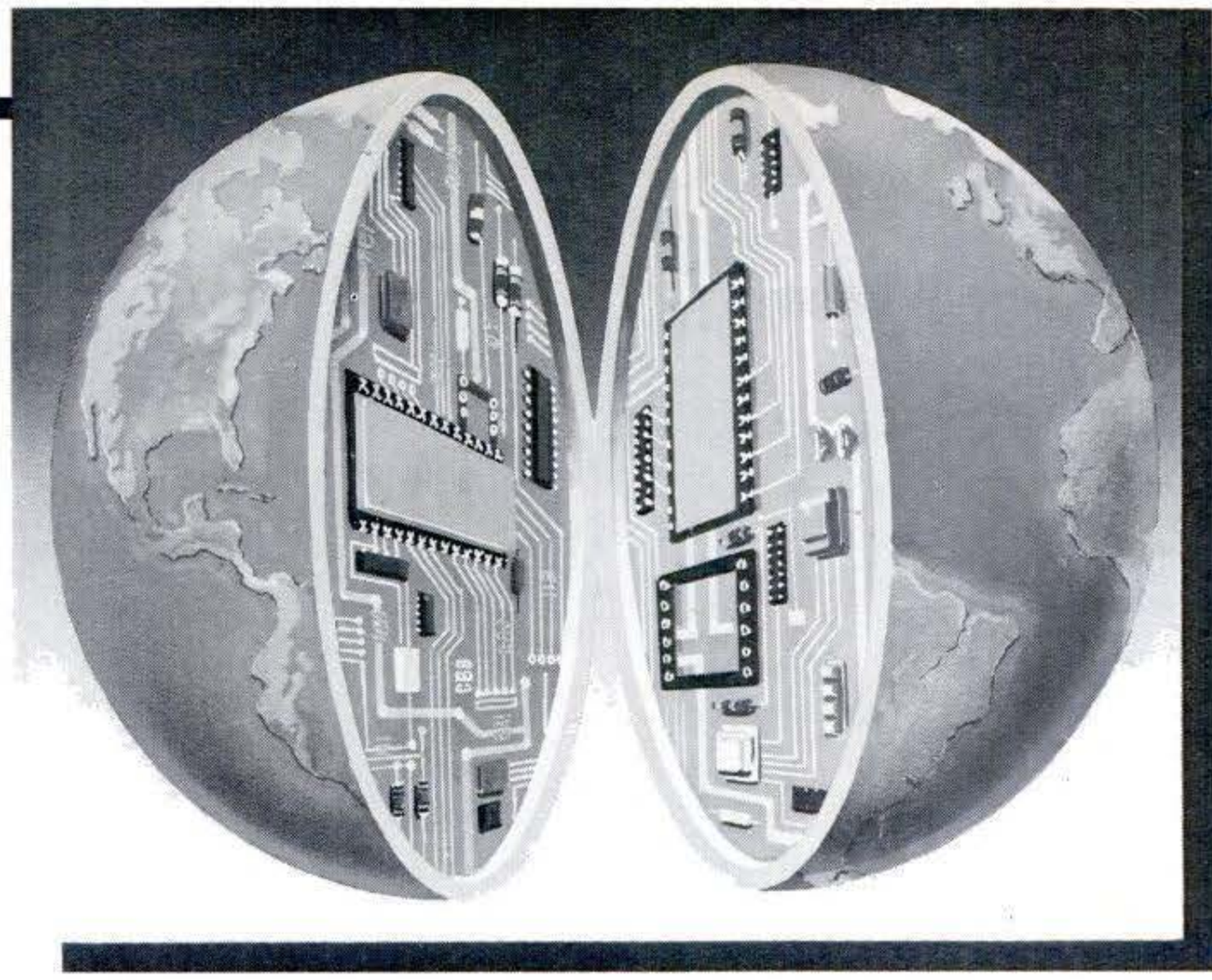

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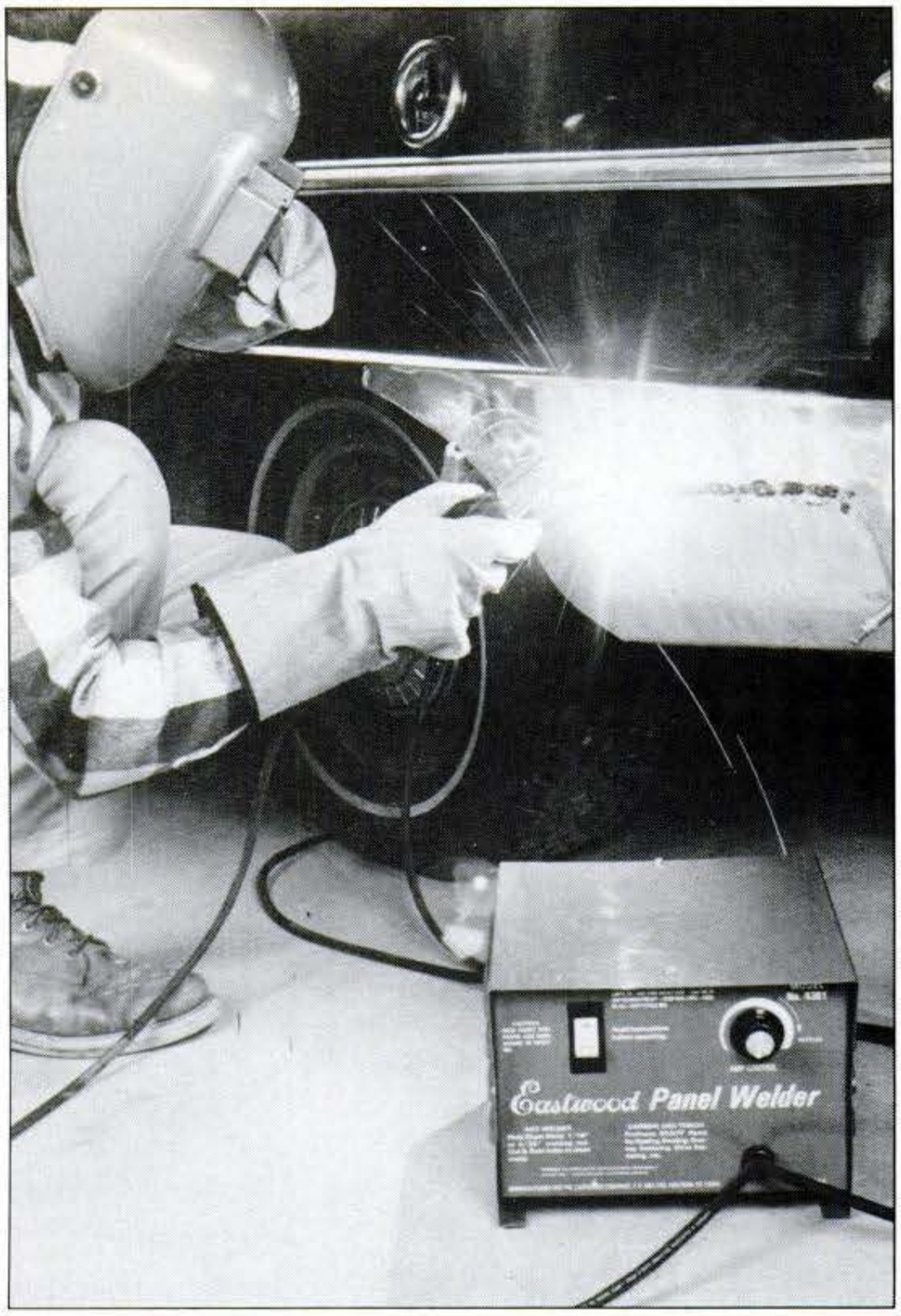
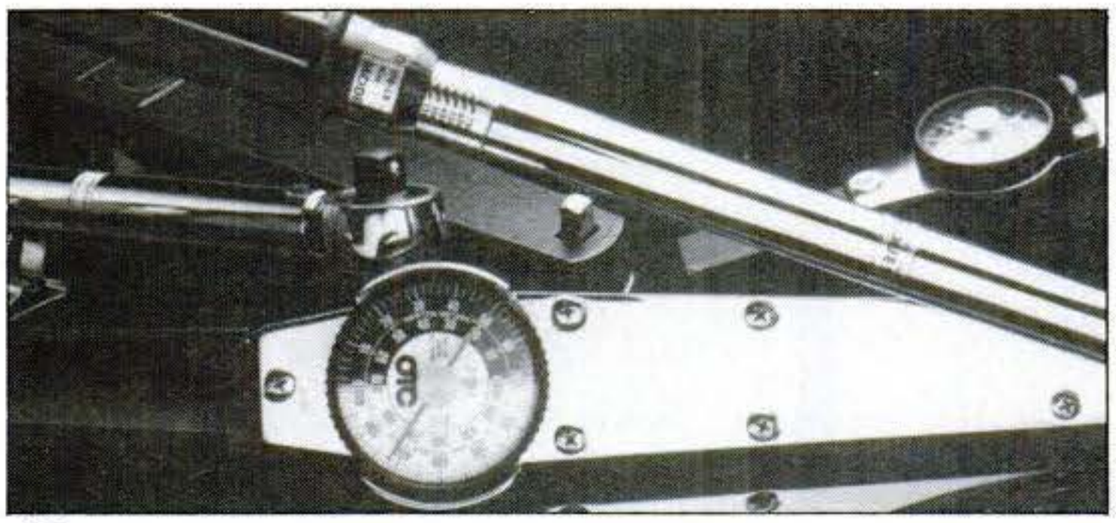
What's New for Your Car

BY JACK KEEBLER

Panel patcher

Plug the Panel Welder into a 110-V outlet, and make smooth low-distortion seams in automotive sheet metal without using special attachments. Made by The Eastwood Co. (Box 296, Malvern, Pa. 19355), Panel Welder sells for $179, complete with a helmet and instructions.





Torque tools

Using a torque wrench during automotive jobs can make service more trouble-free. Two lines (clicker and dial-indicator types) of Accutorq wrenches are now available from the OTC Div. of Sealed Power Corp. (655 Eisenhower Dr., Owatonna, Minn. 55060); $95–$316.

Emergency CB

Drop the magnet-mount antenna on the roof, and plug the RA 100's power cord in the lighter: You're ready to call for roadside assistance. The hand-held unit has a built-in microphone and speaker, and fits in the glove box. Sparkomatic Corp., Milford, Pa. 18337; $60.

200-mph street tire

Bridgestone's 17-in. ultra-low-profile RE71 is the leading edge in performance street rubber. Available in 40 and 45 aspect ratios, the tire stays directionally stable even when pressure is lost, so you won't need a spare. It debuts on the limited-production Porsche 959.

Parts bath

Made of welded steel with an enamel finish, the TKL-16 parts cleaner features a 170-gal./hr. solvent recirculating pump. In case of a basin fire, a fusible link drops the hinged top to extinguish the blaze. Transco Equipment, 4790 Chapel Ct., Hubertus, Wis. 53033; $230.

Key-code start

Switch on the key, and a red light glows. You have 15 sec. to punch a four-digit code into the anti-theft unit's pad to get a green light and allow the car to start. Trying to bypass the device sounds the horn. Cannon Rubber Ltd., Ashley Rd., Tottenham, London N17 9LH, England.

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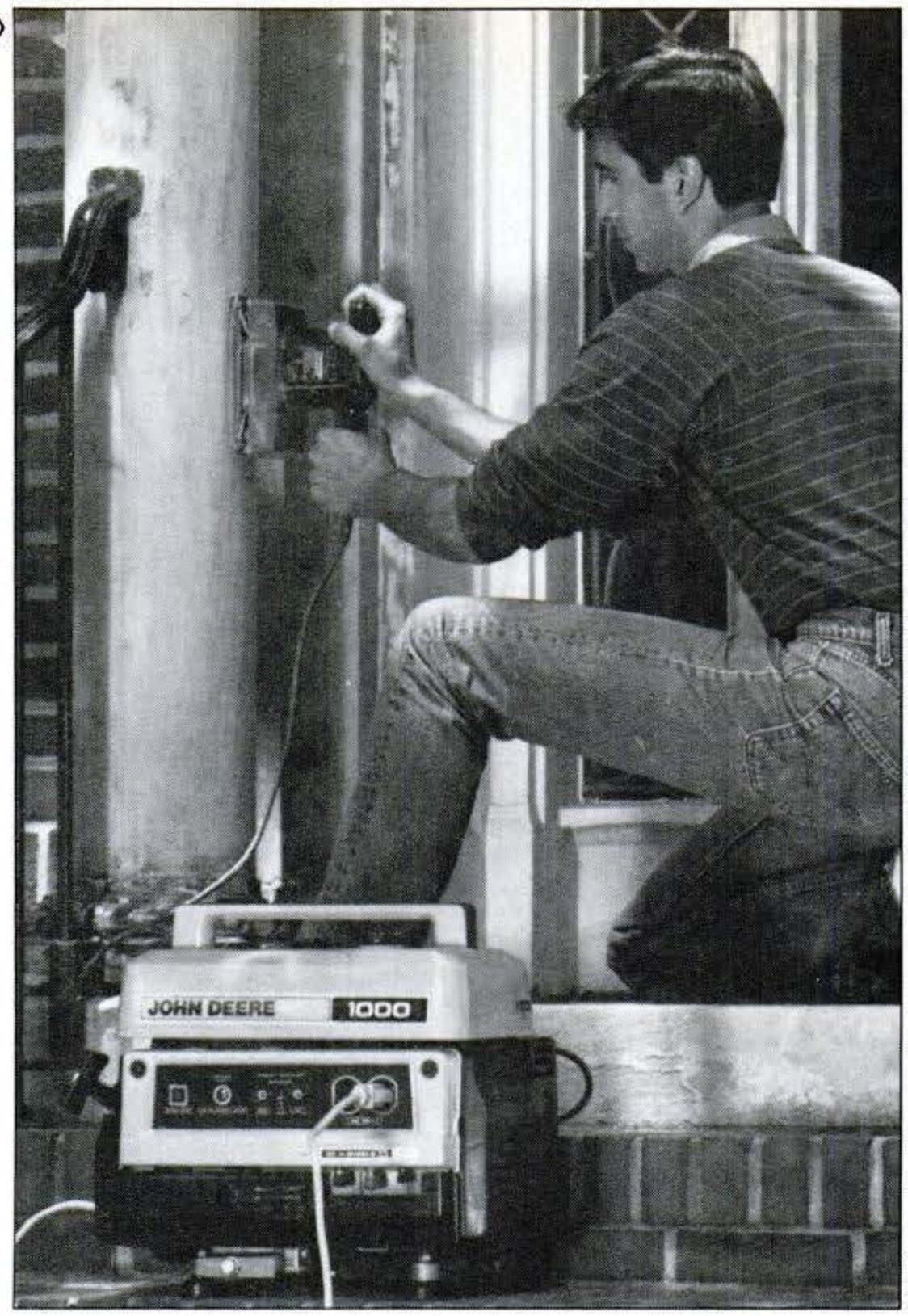
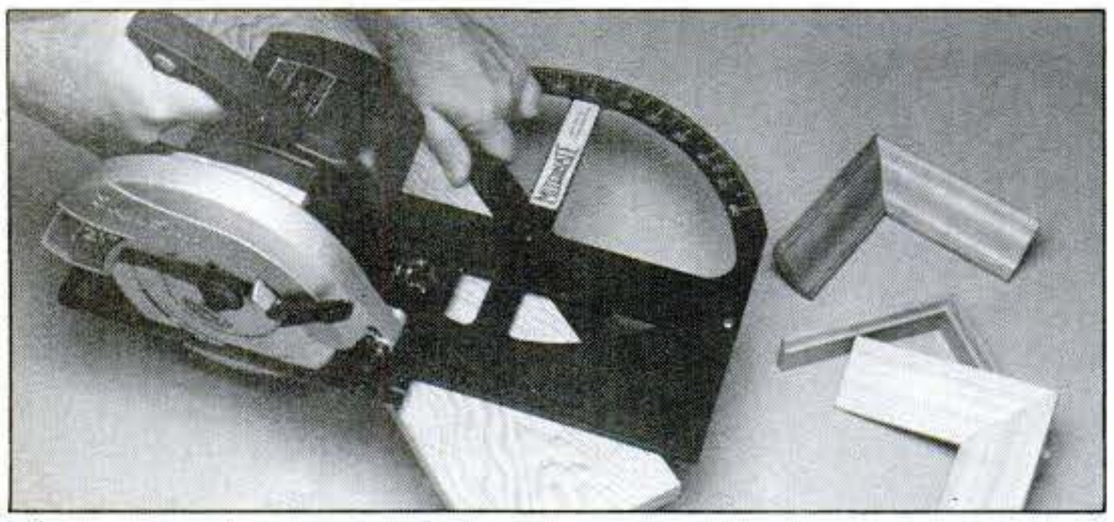
What's New in Tools

BY V. ELAINE GILMORE

Porta-power

A portable generator will power your AC tools or TV far from any outlet. John Deere's model 1000, the smallest in a new line, belts out 1,000 W for starting and 850 running watts. Fill its 1.2-gal. gas tank, and it will keep things humming for nearly 5 hrs. $540.



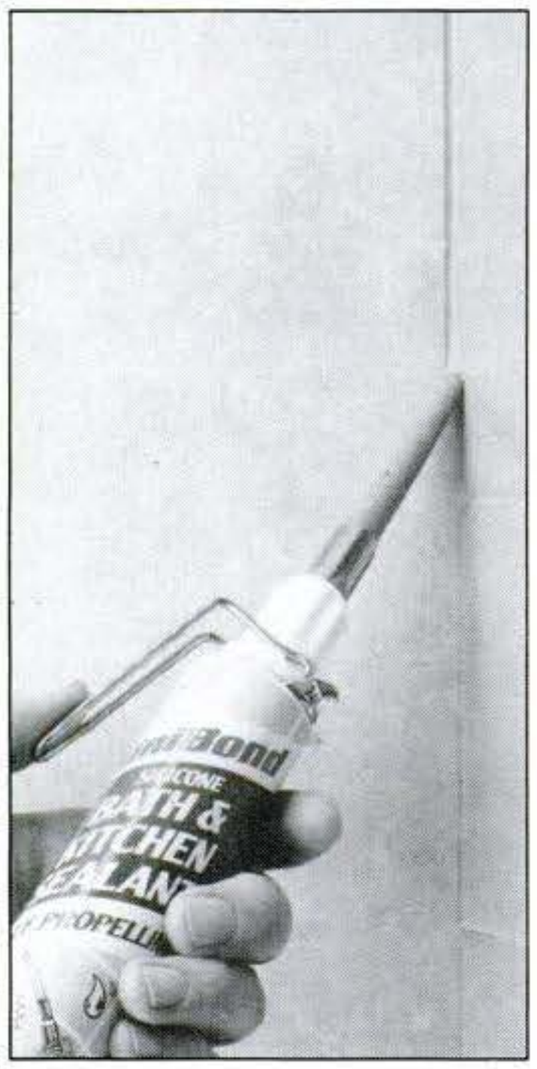


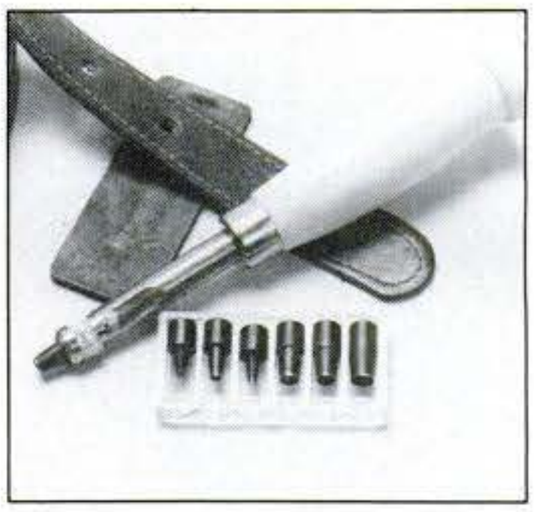
Cutting corners

Mitermate is a cheap alternative to a power miter saw. Teamed with a circular saw, the $25 guide gives you left and right miter cuts, bevels, and compound miters. Use it also as a framing tool and angle measurer. Matrix Enterprises, 8804 Citation Dr., Lake Park, Fla. 33418.

Self-propelled caulk

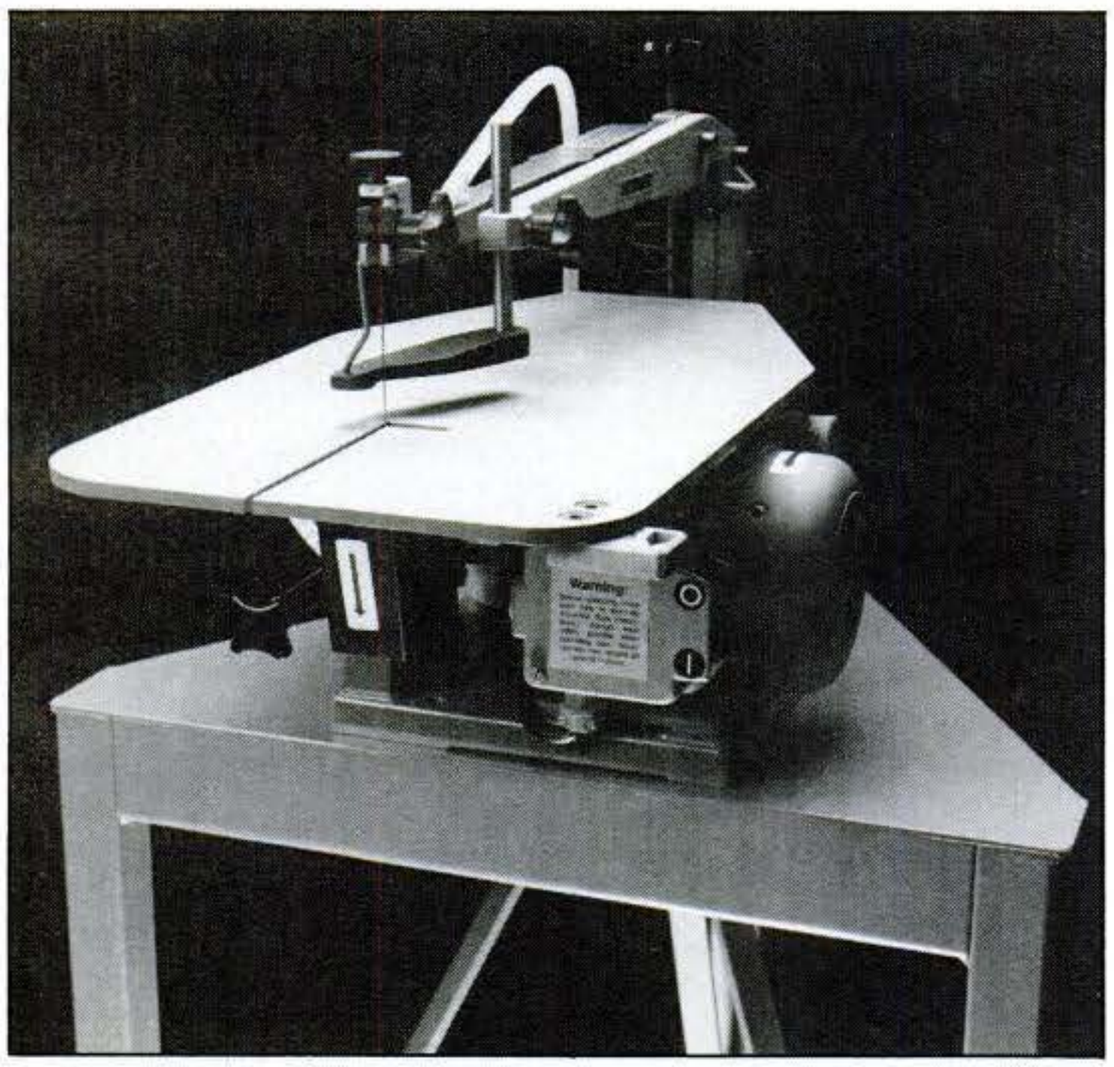
This silicone kitchen and bath sealant flows out of its tube at the touch of the trigger, which controls a gas-driven piston. Flow rate is steady and cutoff immediate, claims the maker. The caulk comes in 11 colors. Unibond, Stanhope Rd., Camberley, Surrey GU15 3DD, England.





Leather drill

As you press down on its handle, the Mini-Drill rotates, cutting a perfect circle in leather, paper, fabric—even wood and light metal, says Thomas Robinson Import-Export (Box 80583, Seattle, Wash. 98108). The $15 price includes seven cutters (1/16- to 1/4-in. diameters).



German scroll

The latest Hegner scroll saw, the Multimax-2, will make intricate cuts so smooth they hardly need sanding, it's claimed. It has a 60% larger table and improved blade-changing system over the former model. $995. Distributor: AMI, Ltd., Box 312, New Castle, Del. 19720.

Gutter scoop

Gutter Getter was invented by a Mount St. Helens-area homeowner after the volcano belched and filled his gutters with ash. The long, flexible-plastic scoop can rid your gutters of more-conventional debris. Working Products, Box 25094, Portland, Ore. 97225; $10.

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 [Continued from page 52]

for primary structures, laminar-flow wings, an all-electric secondary power system, and even expert systems or artificial intelligence on the flight deck. That aircraft could reduce trip fuel by sixty percent over today's levels."

Douglas's schedule will make Boeing first with an all-new prop-fan airliner. The company expects to lock in the design of its 7J7 in mid-1987 and begin to deliver the first planes in early 1992.

The base 7J7 has a single-aisle circular fuselage 164 inches in diameter —16 inches wider than a 757—and will carry 150 passengers over a 3,000-mile range. The fuselage could be changed to a twin-aisle 180-inch configuration after current studies are completed, say Boeing spokesmen. The 7J7 is 14 feet shorter than a 727, but has narrower and longer wings and a stubbier T-tail. Its twin prop-fan engine pods are mounted high on the rear fuselage to let the propeller blades clear the ground.

Because the 7J7's T-tail will be smaller and less swept than current airliners, flight stability will be decreased. Some aerodynamic instability is desirable because drag is reduced, thus increasing speed and fuel efficiency. A computerized stability-augmentation system may be included in the 7J7 to compensate for the lower static stability. The system would constantly monitor and command small changes in control surfaces to keep the ride smooth.

The 7J7's flight deck will be a marvel of glass and electronics. Toggle switches are out; touch panels are in. Boeing will use color flat-panel displays instead of dials and gauges, or even the bulky, hot-running cathode-ray tubes now standard in its 757 and 767 airliners. The company has yet to decide between liquid-crystal or thin-film electroluminescent displays. "Flat panels eliminate twenty inches of flight-deck depth," Bates explains, "and save fifty percent in cost, sixty percent in volume, seventy percent in weight, and eighty percent in power. They're also more reliable." Pilots will also be able to choose which displays to watch, moving them on command from screen to screen.

The pilots will control roll, pitch, and yaw with a pistol-grip mini-stick controller that looks like a short, fat joy stick. "The first study we did with our simulator was on the mini-stick controller," says Sheryl Chappell, a research psychologist and human factors engineer at Ames. "The beauty of it is that it unclutters the cockpit. The old yoke just took up too much valuable real estate."

Not unexpectedly, computers will have as much to do with flying the plane as the pilots. "We want most of the systems to be automatic," Bates notes. "If something fails and a backup system takes over, we don't even want the pilot to know about it. There will be messages for the maintenance people later on."

Because computers will be directly involved in flight operations, they can take on chores once handled only by the pilots, but it's important that they not be intrusive. Throttle control is one example:

"Pilots like to use full throttle on takeoff," Chappell says. "But a takeoff from San Francisco really needs less power than one from Denver, because of the thinner air at the higher altitude. So the computer can be programmed to let the pilot hit full throttle in either place, but get only the power needed to do the job."

The result is a happy pilot, a fuel-efficient takeoff... and a happy airline executive. PS

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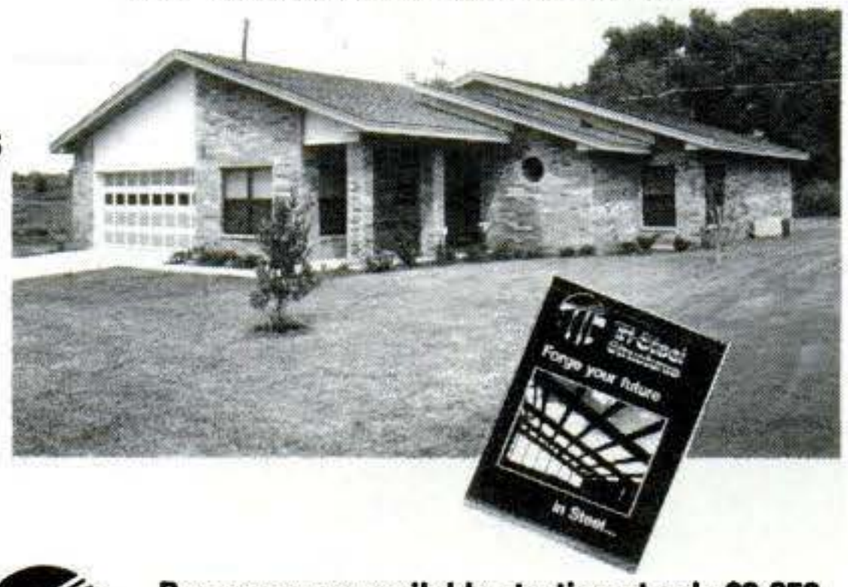

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Cold fusion

[Continued from page 54]

time I went to Los Alamos," Jones recalls. "It looked pretty ominous to airport security."

The latest versions of these capsules can hold a deuterium-tritium mixture at the density of liquid hydrogen (up to 3,000 atmospheres) and a temperature of 600 degrees Kelvin.

The results of the initial experiments were encouraging, and even provided a few pleasant surprises. The resonance phenomenon was indeed present, as predicted, and there turned out to be multiple fusions per muon, even when the capsules were cooled by liquid nitrogen to a temperature of only 100 degrees K, or minus 173 degrees C. "You could call that cryonuclear fusion," says Jones. "That's really cold. And the results were better than theory: The resonance was really strong."

Moreover, the resonance phenomenon was temperature-dependent, an effect that had not previously been seen. As the temperature was increased—and as the density of the fuel was increased—the number of fusions per muon went up. The temperature range tested so far is from 13 to 800 degrees K. At this upper limit, Jones and his team have achieved 170 fusions per muon. "Our experimental results exceeded predictions from theory by a factor of two," says Jones.

Not so sticky

Another welcome surprise concerns the sticky problem called, appropriately, sticking. Theory predicted that one percent of the muons in the cycle would stick to the alpha particle (a helium-4 nucleus) emitted in each fusion, thus reducing the rate of catalysis. This was viewed as a serious bottleneck to practical cold fusion.

But, says Jones, "the results of our most recent tests, last November, are tantalizing. They show that sticking is much smaller than predicted, for reasons that the theorists can't explain. And that's very encouraging. It may not be a bottleneck after all."

To achieve electrical break-even—as much electricity out as you have to put in—in muon-catalyzed fusion, some 500 fusions per muon are needed, Jones estimates. That's about three times the number so far achieved. But Jones believes it is not out of reach. And if a hybrid fission-fusion reactor were used, "using a uranium blanket and some clever engineering," only 100 fusions per muon would be needed.

"After four years of intensive research in the United States," says Jones, "muon-catalyzed fusion has been raised from the level of a laboratory curiosity to a potential means of achieving clean fusion energy." PS

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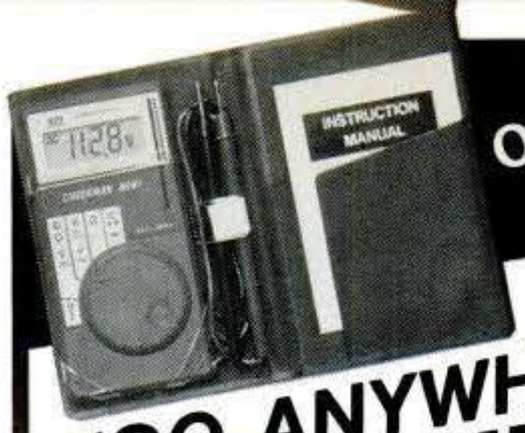

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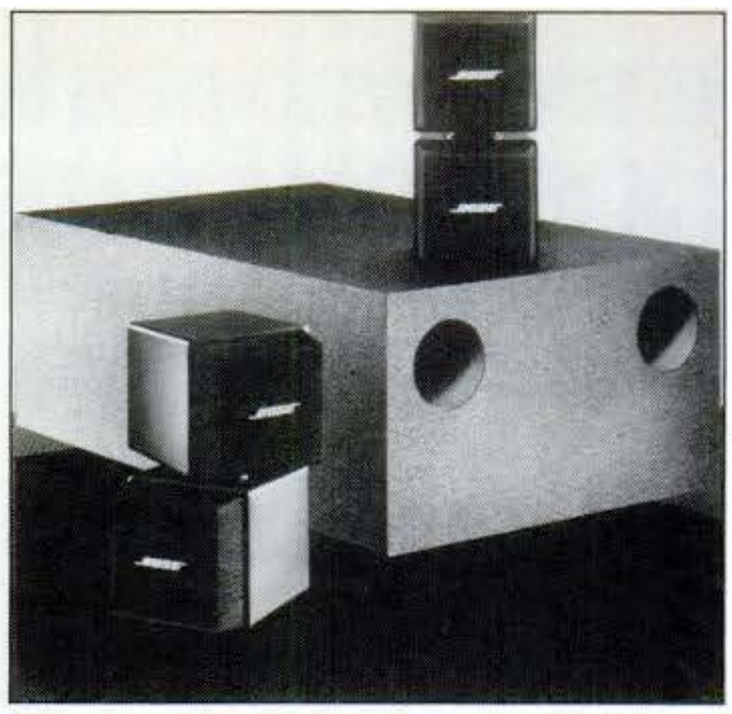

Hide-and-speakers

Everyone assembled in a suite of one of New York's tonier hotels knew we were there to listen to a new speaker system from Bose Corp. But where were the speakers? There was nothing visible at the front of the room except a pair of planters.

Suddenly, crisp musical sound with a solid, undistorted deep bass filled the room, its source seemingly invisible. The secret was revealed in two stages. First, Bose men whisked the plants out of the planters, unmasking two pairs of tiny black boxes. Next, they pulled a typewriter-size box—origin of the boomless bass—from its hiding place under a chair.

This AM-5 Acoustimass Speaker System (price: $699) is yet another brainchild of the indefatigable Dr. Amar G. Bose. It uses two pairs of small cube-shaped boxes, each housing a wide-range 2½-inch driver. Left- and right-channel speakers are each formed by the cube pairs, ingeniously connected by a telephone jack so that each cube can swivel 360 degrees.

The system's real wizardry is packaged in the black box called the Acoustimass module. It was designed by Bose in an extension of the mathematical analyses that led to a previous system, the Acoustic Wave ["Big Bass from a Little Box," PS, April '85]. The module contains two six-inch woofers. The front of each driver cone feeds a ported chamber tuned to 90 hertz; the back of each driver feeds a separate ported chamber tuned to 45 hertz. Only the mass of air contained in the port—a simple cardboard tube—is moved into the room. The result is reduced cone motion and lower distortion, with correct stereo imaging from just about anywhere in the room.
—*Arthur Fisher*

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New Stitch Welder Tames Sheetmetal Distortion

Our Customers Write:
"Before buying your Stitch Welder I was ready to throw my electric welder in the trash. No matter how hard I tried, the amps could not be set low enough to prevent burning holes in the sheetmetal. I now have a useable piece of equipment thanks to your Stitch Welder."

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Simplifies Home Bodywork

With a little practice anyone can weld automotive sheetmetal with virtually no distortion or burn-through. The Stitch Welder makes it easy to run a continuous weld bead on quarter panels, body patches, floor boards, etc. If you've ever tried arc welding body panels you know the high amperage output plays havoc on thin gauge metal. Our new Stitch Welder controls amperage to produce professional, uniform welds similar to those made by expensive wire-fed MIG machines.

Special Circuits Control Arc Welding

By directing the arc welder's current through a copper wound solenoid and diode the Stitch Welder creates a unique pulsing action. This pulsed current produces an easy-to-control arc necessary for clean, uniform weld beads on sheetmetal. There are no buttons or triggers — the pulsing action is automatic! All you do is guide the electrode.

Welding with the Stitch Welder is faster and easier than conventional stick welding. The arc's self-starting, so there's less chance of rod sticking. Once you strike an arc lay the rod on the metal and let the machine do the work. After some practice you'll produce welds requiring little grinding or filling. Remember, as with any welding tool the Stitch Welder requires practice to produce good results. We've included complete detailed instructions.

Attaches to Any A.C. Welder

The Stitch Welder's five-foot power cord attaches to the electrode holder on any A.C. arc welder (must run at 80 amps or less). Uses standard arc welding rods up to 3/32" and will weld down to 22 gauge steel and stainless. The tool body is cast aluminum with a vinyl insulated grip for positive control. Electrodes held with a set screw and can be easily replaced. Tool designed for years of trouble-free service. ALWAYS USE PROPER SAFETY PRECAUTIONS WITH ANY WELDING EQUIPMENT.

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For fastest service call toll-free 1-800-345-1178 (in PA, 215-644-4412) and charge your Stitch Welder to Visa, MasterCard, or C.O.D. ($2.75 additional fee on C.O.D.) Mail orders use coupon.

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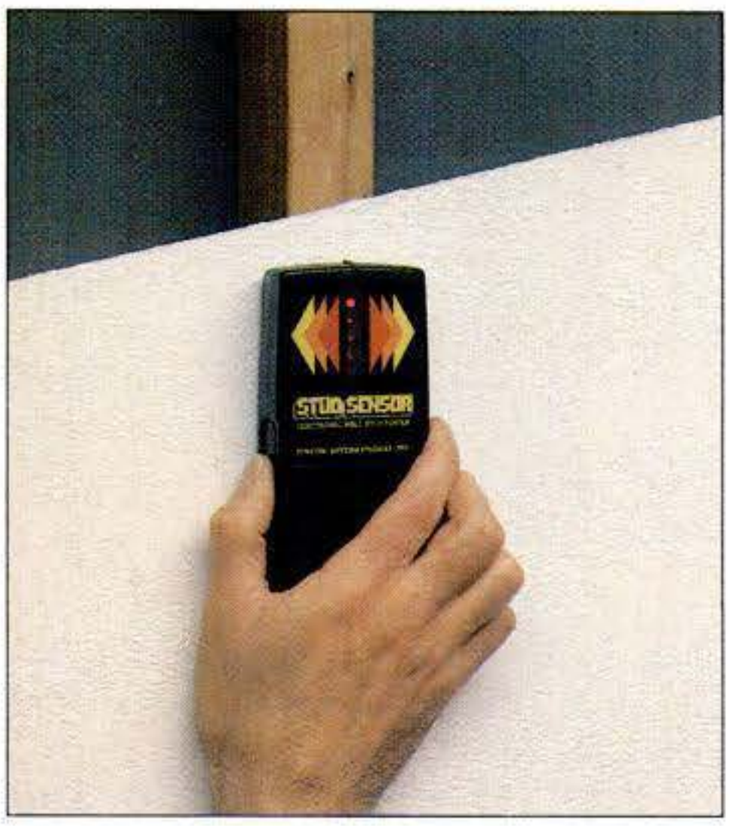

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Ultra-sensitive blood test is a new anti-crime weapon

Lady Macbeth knew how damning a spot of blood could be—she spent her nights trying to scrub away the proof of her role in a murder. Now a new, highly sensitive blood test can also use a drop of blood to identify a culprit.

A drop of blood contains hundreds of proteins. The makeup of each of these compounds may vary from person to person. FBI researchers have devised a method, called isoelectric focusing, that identifies the variations and uses them, like fingerprints, to help tip the scales of justice.

Blood tests have been a forensic tool for a decade. The traditional method, electrophoresis, involves dropping a blood sample onto an electrically charged gel. "All blood proteins carry a charge," says James J. Kearney, chief of the FBI's serology unit. "When you place them on the electric field, they migrate. If they're negatively charged, for example, they'll move toward the positive pole." The separated proteins, or markers, are then stained to see which variation is present.

Any given marker, however, has a limited repertoire of variations. To weed through a field of suspects, you narrow down the probabilities by increasing the number of markers used. Multiply the 1-in-10 chance of an individual having a certain variation of one marker by the 1-in-60 chance of his having a particular variation of a second marker. Only a single person in 600 will have those two variations. "If you look at enough of these markers, you can eliminate a specified population of individuals, whether it's a community of 40,000 people or the population of the United States," says Kearney.

In electrophoresis, however, markers can be tough to identify. A protein may break up as it migrates, leaving bits and pieces of itself scattered across the gel. So you need a large sample; the more protein present, the better chance of some traveling intact. Even if the marker is visible, the test takes four hours.

Those problems caused Bruce Budowle, a research chemist, to turn to isoelectric focusing. "This method adds a pH gradient to electrophoresis," says Budowle. "There's not just an electrical field attracting the charges on the proteins, there's a constant change from an acidic environment to a basic environment. This extra effect can lock a protein in a particular spot on the gel."

In isoelectric focusing, a migrating protein will stop at its isoelectric point —the place along the pH gradient at which the net charge on a molecule is zero. "When a molecule reaches that narrow point, it'll stop and begin to focus in distinct bands," explains Kearney. A smaller sample can be used—less than 50 microliters. And because the gel is thinner than in the old method—0.7 versus two millimeters—it can take a higher voltage charge and cool faster. This cuts testing time to an hour.

The clearness of the protein bands has also let scientists use more markers, and to try to expand the test to other substances. "We have a real interest in adding markers from semen, hair, and other biological samples," says Budowle.—*Richard Layne*

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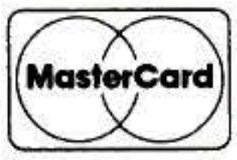

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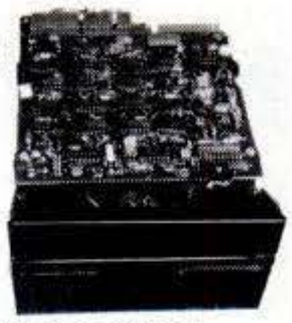

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Mfr — MPI-52S
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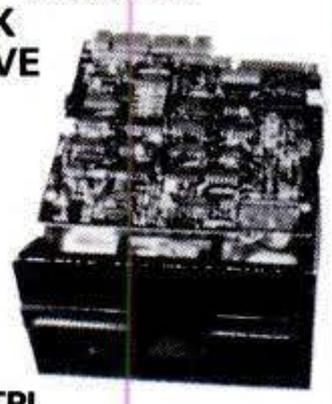

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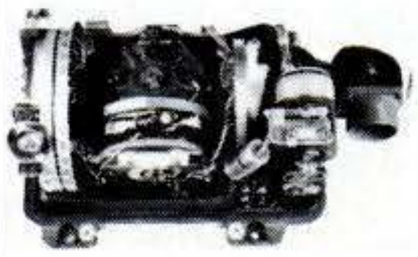

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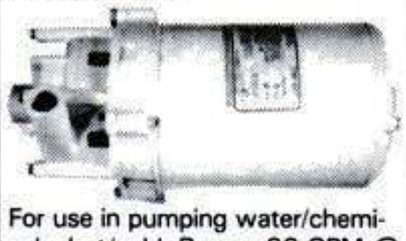

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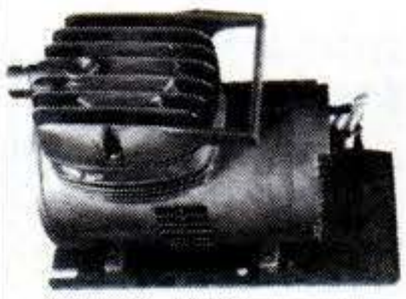

Produces up to 33 PSI. For air brush, paint spraying, tire & mattress inflation. 115VAC, 50/60 Hz. Capacitor-run motor.
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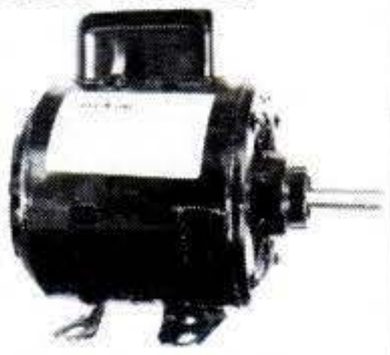

CCW rotation; 115 VAC/60 Hz., 9.2 amps. Shaft: ⅝" dia. x 2"L with 3/16" keyway slot.
Dim.: 6½" dia. x 8¼"H x 8¾"L
Mfr — GE #5KC47KR319AS
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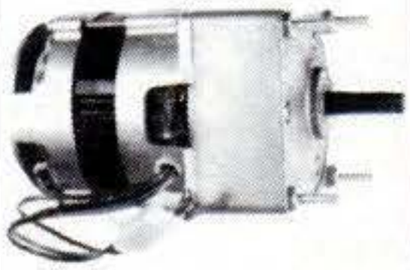
55 RPM SATELLITE POSITIONING MOTOR



Reversible capacitor induction motor. 115V/60 Hz., 30 in./lb. torque. 14W. Front flange mount OA Dim.: 3¼"D x 5"L.
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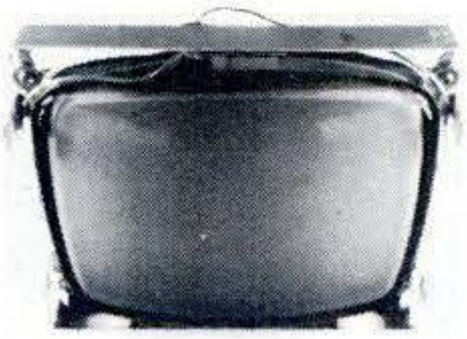
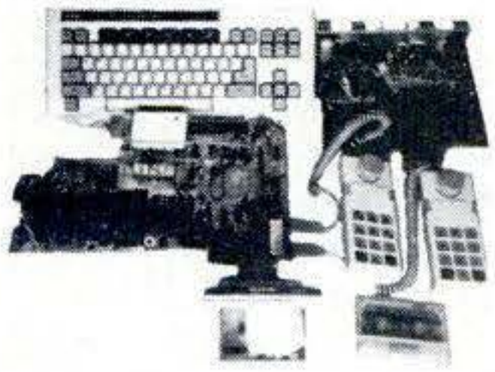


12" Monitor
(Controls front panel mounted)
12", green phosphor, high resolution (12 lines center) and bandwidth from 10Hz to 30Hz ± 3dB. Op. volt.: 120/240VAC, 50/60Hz., 65VA max. Controls front panel mtd.
Mfr — Motorola – Alpha Series
Item #10043 **$29.95** New

15" Monitor
15" screen. Same specs as above.
Item #10044 **$34.95** New

ADAM COMPUTER KIT
(Less printer & w/o cabinet)



Build it yourself from subassemblies. No wiring nec. (just plugs together). Hook-up diagram included. Includes: Keyboard, 1 cassette digital data drive, 2 game controllers, power supply, all memory boards, and one cassette. Capable of running CP/M, has built-in word processor. Item #7410.
Complete — **$99.00**

ADAM PRINTER

Complete, less top cover plate. Friction feed. Takes standard paper 8½" x 11". (Customer returns; tested — operational.)
Item #8839 **$69.50**

ADAM ACCESSORIES. . .

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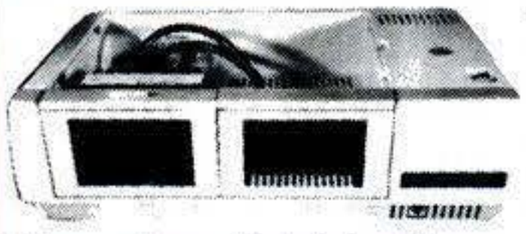
LOGIC BOARD
Item #7231 **$9.95**

GAME BOARD
Item #7679 **$6.95**

COLECOVISION to ADAM EXPANSION KIT



This expansion module just plugs into your ColecoVision. With printer power supply and data drive (both included), you will have a working Adam Computer. Adam keyboard, one Smart basic cassette and hook-up diagram also included.
Item #9918 **$59.50**

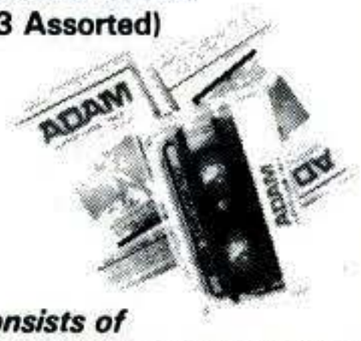
MECHANICAL KEYBOARDS. . .

48-KEY — Timex Z81/1000
Item #6712 **$5.95** New

66-KEY — Commodore C-16
Item #9394 **$5.95** New

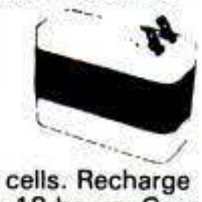
75-KEY — Timex or Adam
For computer upgrade. . .
Item #7429 **$5.95** New

ADAM CASSETTES
(13 Assorted)



Consists of Smart Basic & Buck Rogers (all can be easily erased).
Item #7786 — Bakers Dozen
13 for **$19.95** New

Rechargeable NICAD BATTERY BACKUPS



12V @ 450 ma
Contains 10 AA cells. Recharge rate: 45 ma. 16–18 hours. Case with tab output connections.
Dim.: 2 1/16"H x 1¼"W x 2 15/16"L
Mfr — GE 123233 or equiv.
Item #5443 **$5.95** New

13.2V @ 1.65 AH
Contains 11 C cells.
For model boats, toys, etc.
Mfr — GE #41B035BB00101
Item #5444 **$15.95** New

CORDLESS TELEPHONE

700 ft. Range
Wall or Base Mount
Full duplex: talk & listen simult. Auto redial: last number dialed recall. Comes with attachments for both types of mtg.; incl. AC power adaptor & battery indicator light. Color: brown w/cream. Famous make mfr.
Item #9997 **$29.95** New

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120 VAC, 60 Hz. Excellent indicating system for general purpose applications. Use as a beam direction or position indicator for valves, flaps, gates, etc., when used with a balanced pointer. Type 1 HCT synchros
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(Rechargeable)
For use with model cars, trains, boats, planes, etc.—

6V @ .9 AH
Dim.: 2"W x 2"H x 1⅝"D. Mfr — Globe GC610.
Item #9304 **$3.95** New

6V @ 9.5 AH
Dim.: 5½"H x 4⅛"W x 2⅝"deep. Mfr — Elpower #695
Item #7039 **$14.95** New

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115 CFM MUFFIN® FAN

SPECIAL!
115 VAC/60 Hz., 21W., 28A., 3100 RPM; 5-blade model, aluminum housing. Can be mounted for blowing or exhaust.
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With Speed Control
Item #5345S **$8.95**

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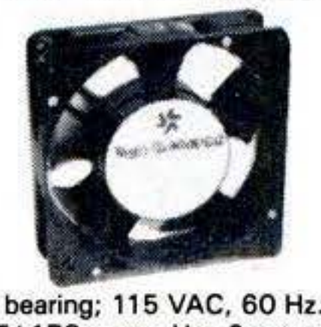
Polarity protected. Can be mounted for cooling or exhaust.
Dim.: 3⅛" sq. x 1¼" deep
Mfr — Rotron – DAYNA
Item #9218 **$12.95** New

150 CFM SUPER VENTURI FAN



Ball bearing; 115 VAC, 60 Hz.; .195/.178 amps. Has 2 sets of mtg. holes (fits standard rack or larger). Can be mtd. for blowing or exhaust. Dim.: 5" sq. x 1½" deep.
Mfr — Rotron
Item #1866 **$19.95** New

12/24 VDC, 1" THIN MUFFIN-TYPE FAN 55/100 CFM

8W. Can be mounted for blowing or exhaust. 5 plastic blades with feathered edges, aluminum housing. Brushless, ball-bearing type.
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Mfr — Centaur CUDC24K4-601
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Mfr — Rotron #MR2B3
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Mfr — Fasco U85
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+5.2V @ 5A
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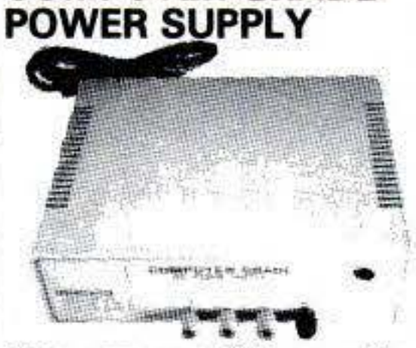
Dim.: 15"W x 2½"H x 6" deep.
Mfr — Todd Prod. #4XS8151A
Item #9749 **$29.95** New

COMPUTER GRADE POWER SUPPLY



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Perforated metal case enclosure.
Dim.: 9½"L x 3½"W x 2"H.
Mfr — General Instrument
Item #7983 **$14.95** New

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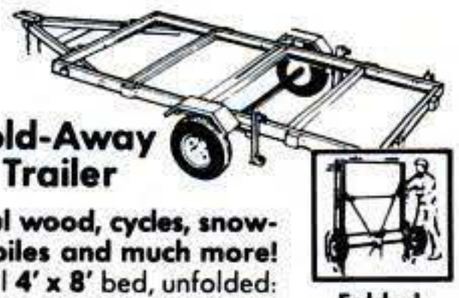

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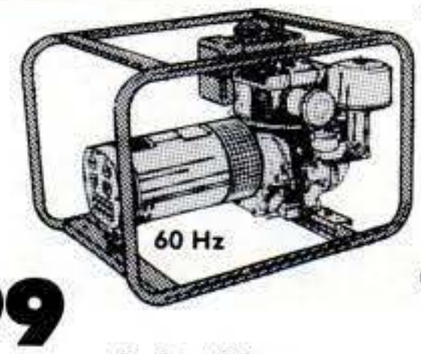

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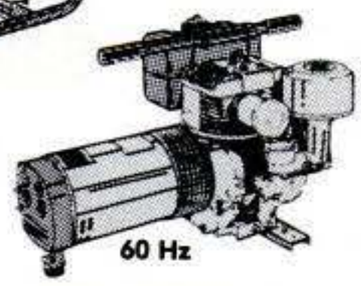

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Though the Rollsteiger has a hefty $12,000 price tag, its expected service life is 15 to 20 years—two to three times that of standard $5,000 to $8,000 electric wheelchairs, according to Frank Guttierrez, executive vice president of the U.S. importer, Dory Corp. (2522 S. Lima St., Aurora, Colo. 80014). He points out that the Rollsteiger can also climb a simple ramp into a van, eliminating the need for an expensive motorized lift.

Using four 12-volt batteries, the 400-pound wheelchair can travel 15 to 18 miles before being recharged from any 110-volt outlet. According to Guttierrez, the vehicle's "tanklike" climbing abilities and maneuverability have also caught the eye of several companies that are considering modified versions for bomb disposal, security purposes, or monitoring nuclear facilities.—*Bruce W. Most*

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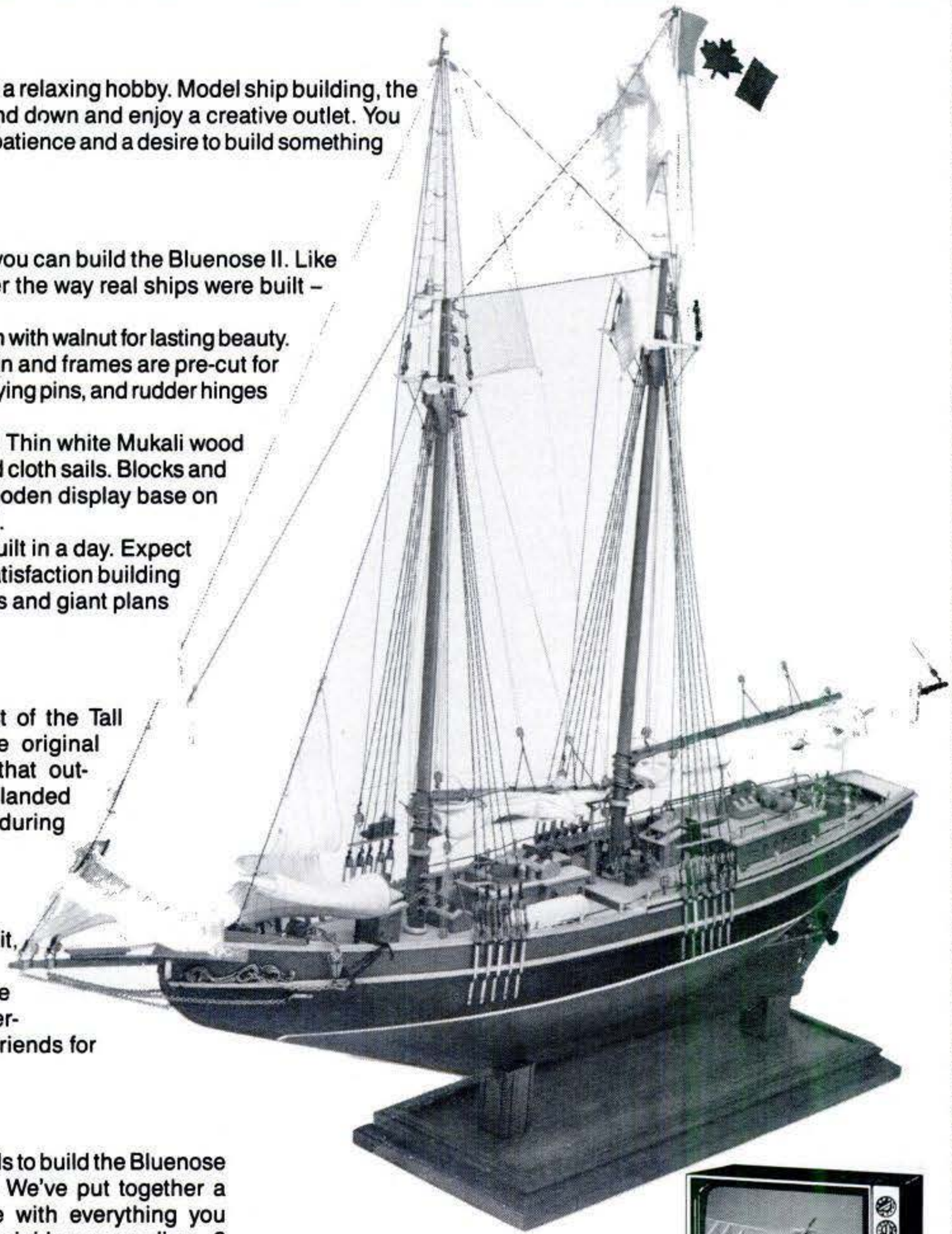

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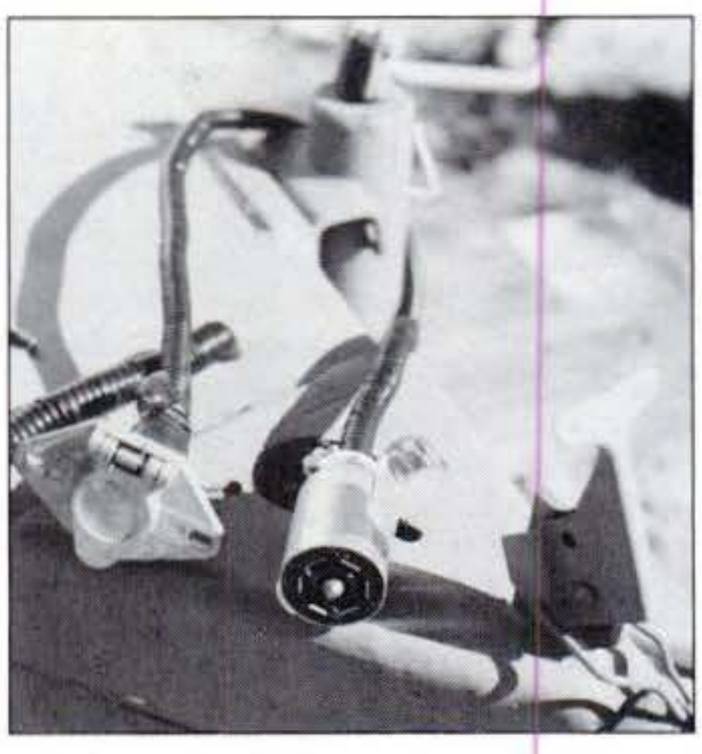
Wiring adapter for a trailer hitch



Getting hitched is no easy task if your connectors aren't compatible. And that's often the case when a single truck is used to pull more than one trailer. Wiring connectors on trailers can have from four to seven poles.

In such times of incompatibility, most people either go without trailer lights or crawl under their truck and start changing wires.

A better and certainly safer solution is to wire up a plug adapter that can be used over and over again at a moment's notice. First, determine the types of male and female plugs you will need. Next, measure for the required wire length, using at least 10 inches of wire to connect the male and female plugs. After making the appropriate wire connections, you may still have some open poles. This isn't a problem, just make sure the trailer's running lights, turn lights, stoplights, and electric brakes are functioning.

Finally, before hitch-up, protect the wires with a plastic wiring harness cover, obtainable at auto-supply stores. —*Hugh F. Williamson*

Plumb-bob shortcut

You could go mad waiting for a plumb bob to stop swinging and come to rest on a mark. A solution is to start with the plumb bob on a short line held at the top mark, with the rest of the string uncoiled and ready to pay out. Let the bob drop smoothly as the string slides through your fingers. You can stop it short for a suspended plumb bob or let the point make a mark at the bottom.—*Richard Day*

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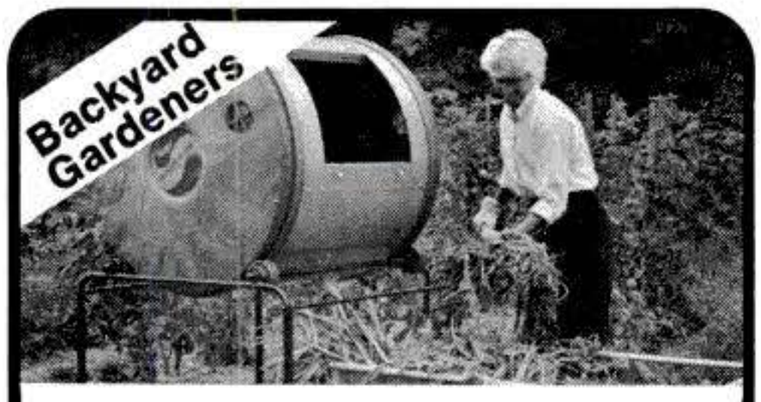

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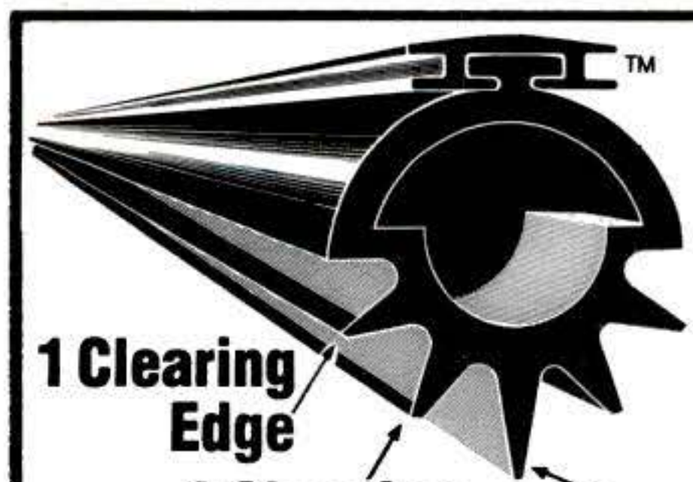

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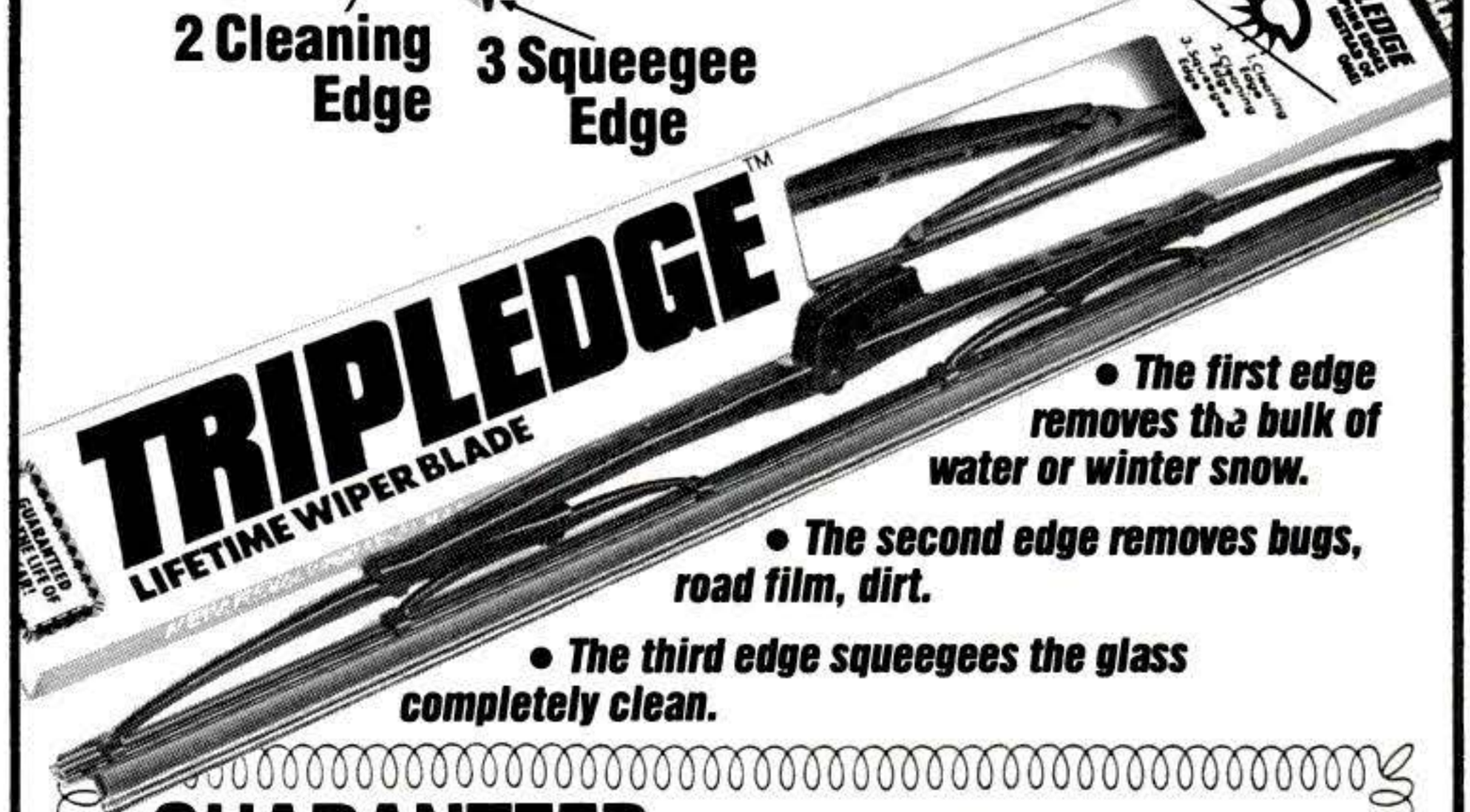

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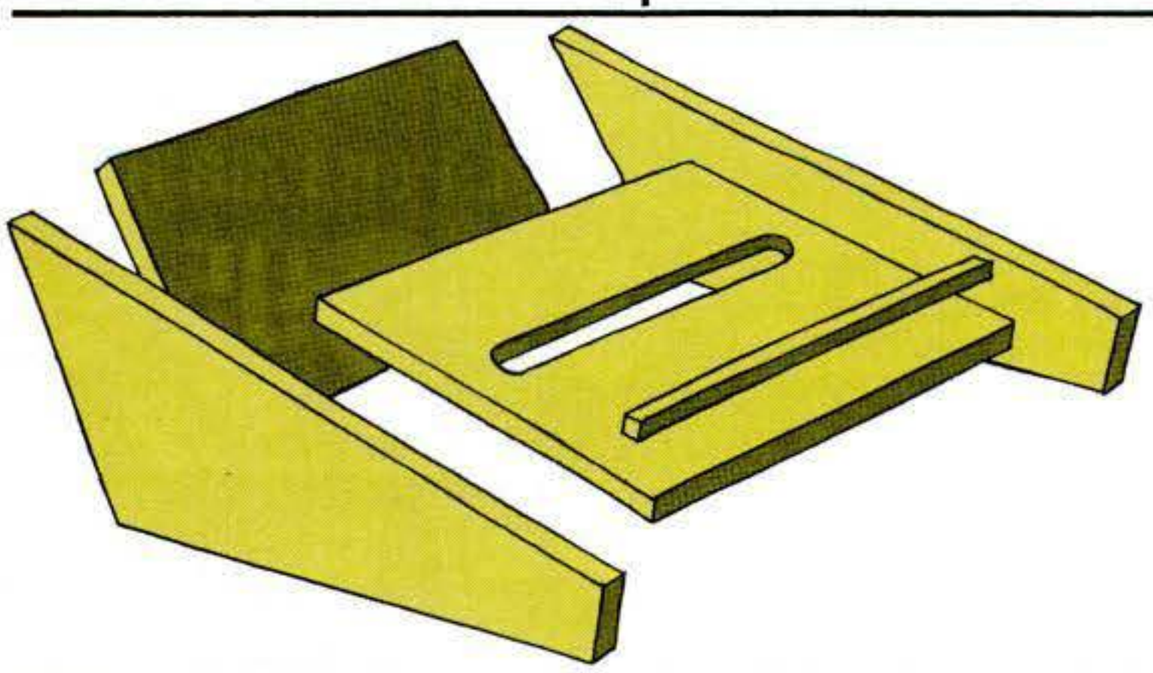
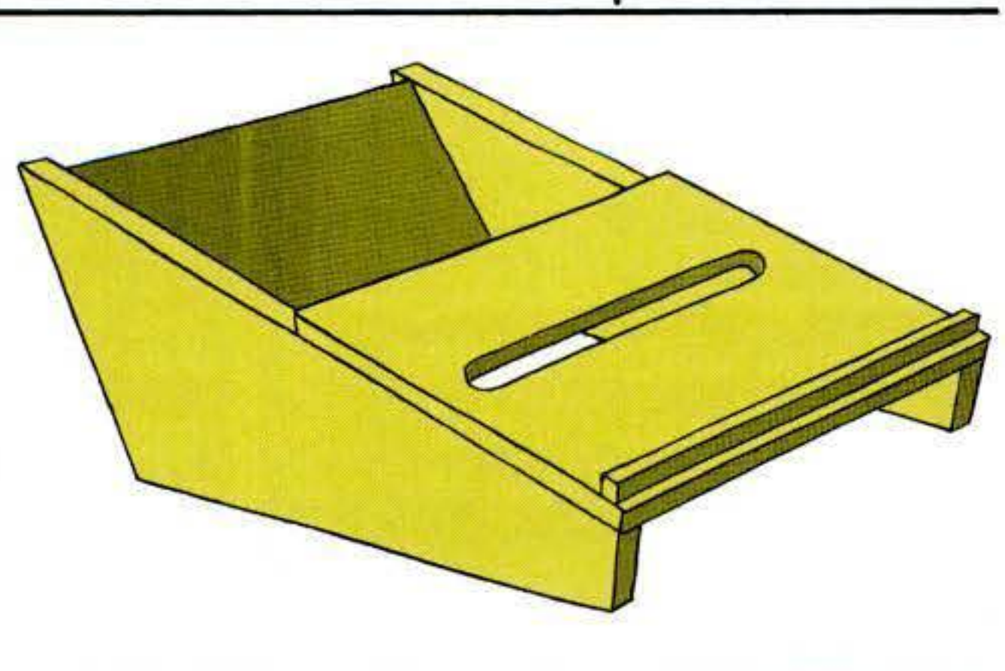
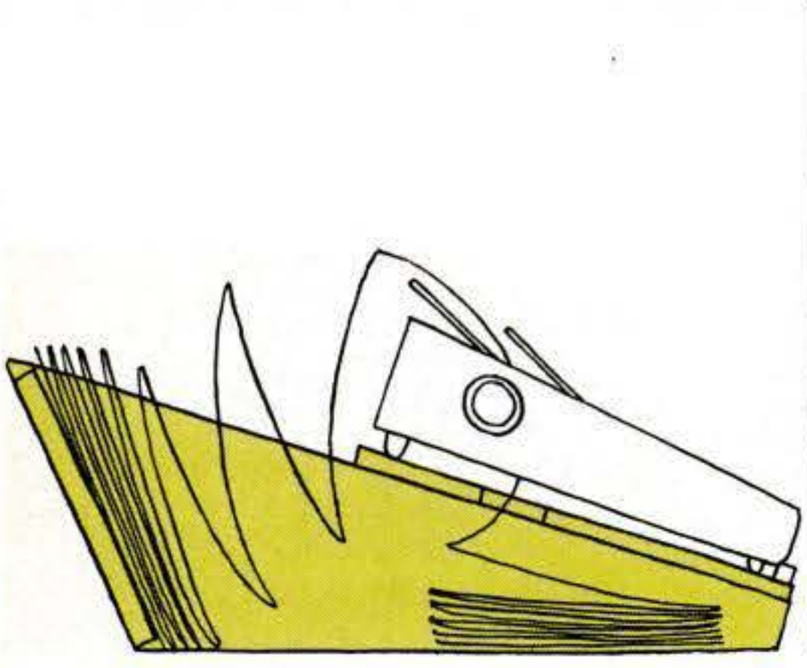
By ROY DOTY







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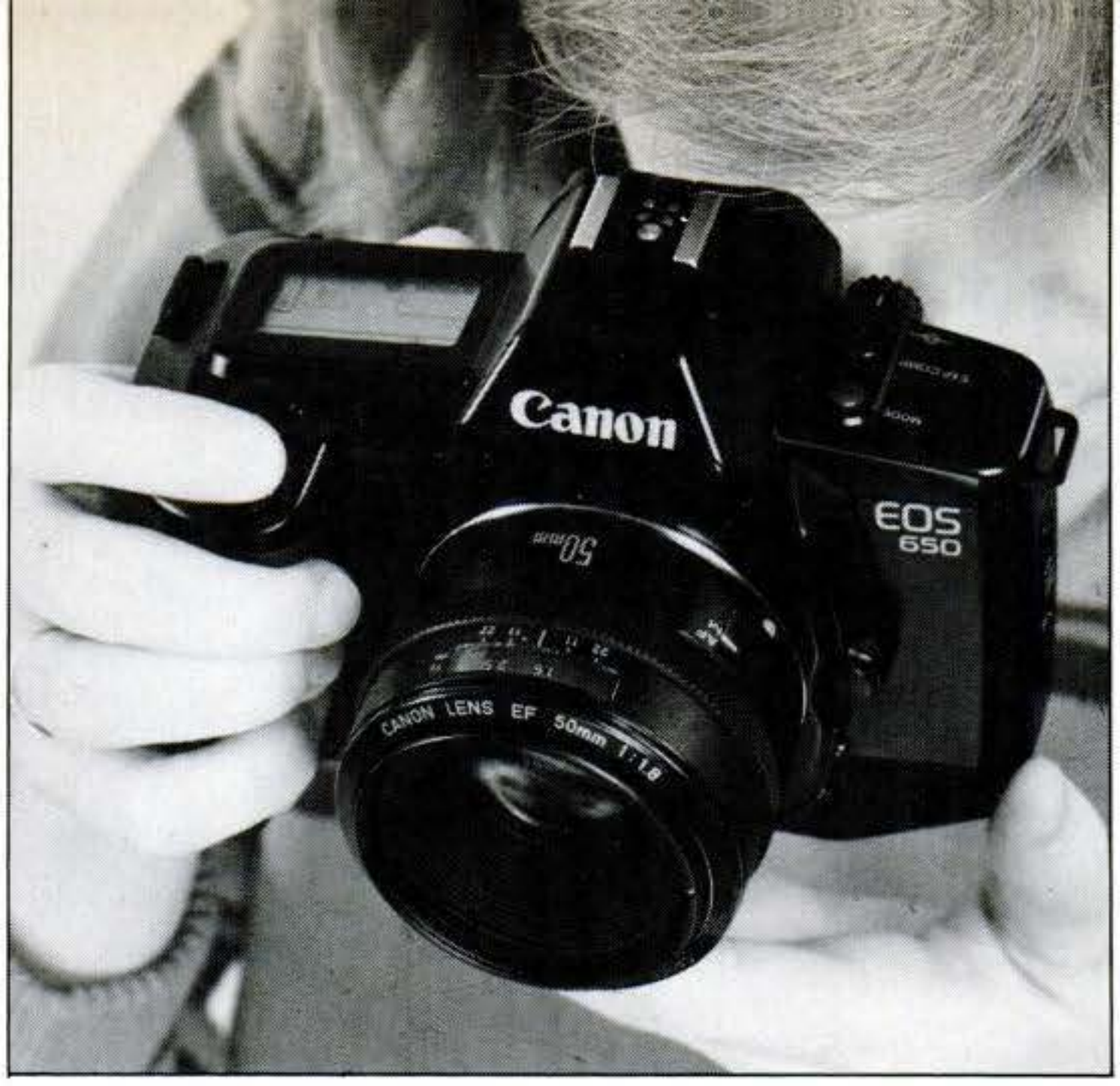
EOS: fast, quiet auto SLR



I don't know exactly what the folks at Canon had in mind when they named their dazzling new camera EOS. True, they say it stands for electronic optical system. But Eos was also the Greek goddess of dawn, and mother of the four winds... fast as the wind, perhaps?

EOS is the latest entry in the competition to build a kind of ideal 35-mm camera, one that has the friendliness of an auto-everything point-and-shoot model yet retains the versatility of a single-lens reflex with its interchangeable lenses. Canon spokesmen claim it surpasses previous autofocus SLRs on several fronts: the ability to perform in very low light—down to EV 1; speed of autofocusing—as fast as 0.36 second in normal light with the normal lens, a 50-mm f/1.8; and very low noise.

EOS departs from convention in radical ways: It uses an all-electronic lens mount, with no mechanical linkages; there is a microprocessor in the camera body and in each lens. Moreover, it is the first autofocus SLR to use a focusing motor in each lens. There are two kinds of focusing motors, each unique. The one used in most EOS lenses is a miniature Hall-effect motor called the autofocus drive. For big lenses like the new 300-mm f/2.8, Canon uses an ultrasonic motor, the first time this design has been used in a consumer item ["Coming: Graceful Robots?" PS, Jan.]. This motor is virtually noiseless; I could barely hear it moving the bulky 300-mm lens, even with the camera at my eye.

Canon is introducing two EOS models, the 650 and the somewhat-more-sophisticated 620. Each has six exposure modes; automatic exposure bracketing; completely automatic film handling; a built-in three-frame-per-second motor drive; and a choice of one-shot or continuous autofocus, or manual focus. Prices are not yet fixed.

I'll report at length on EOS's technical innovations in a future issue.—*Arthur Fisher*

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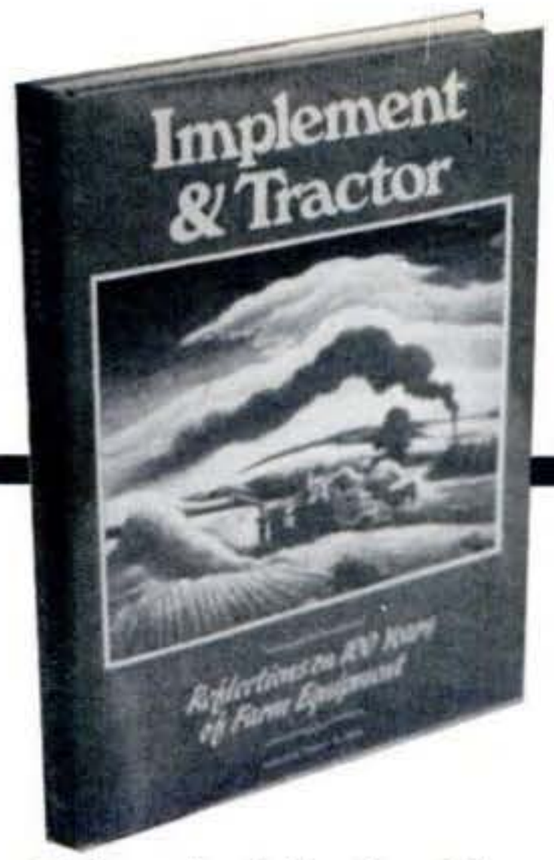

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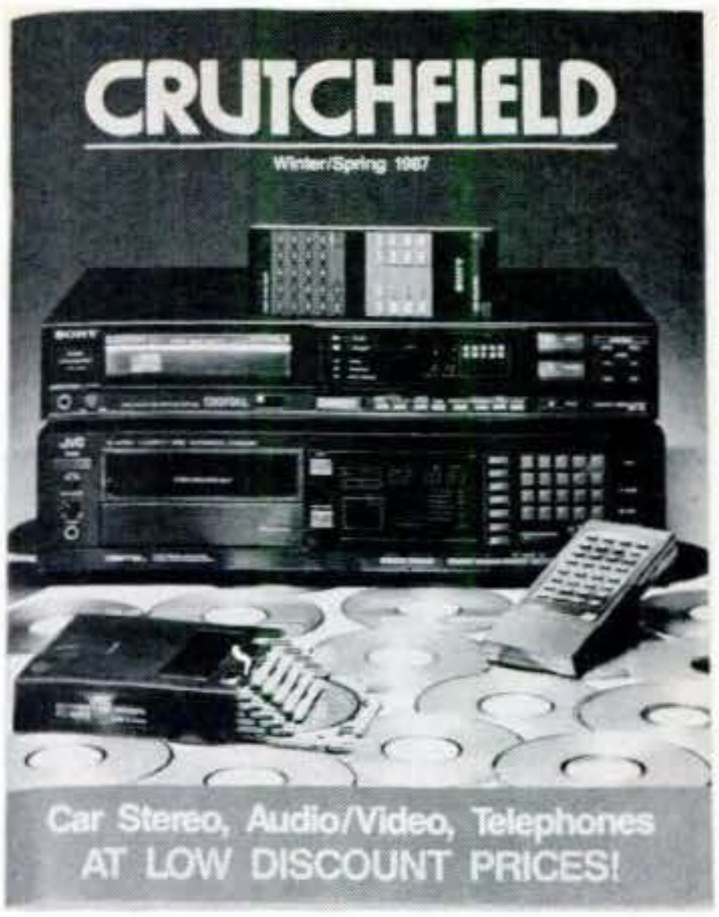

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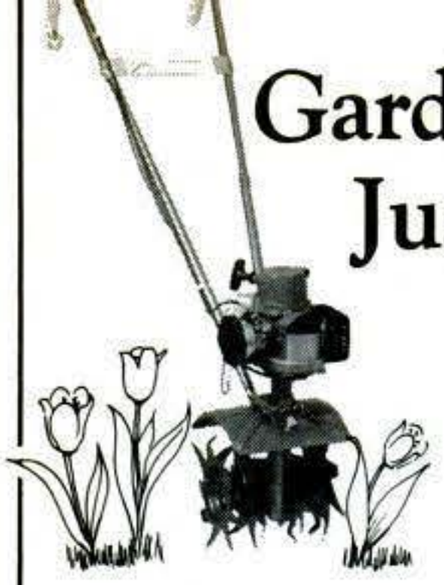

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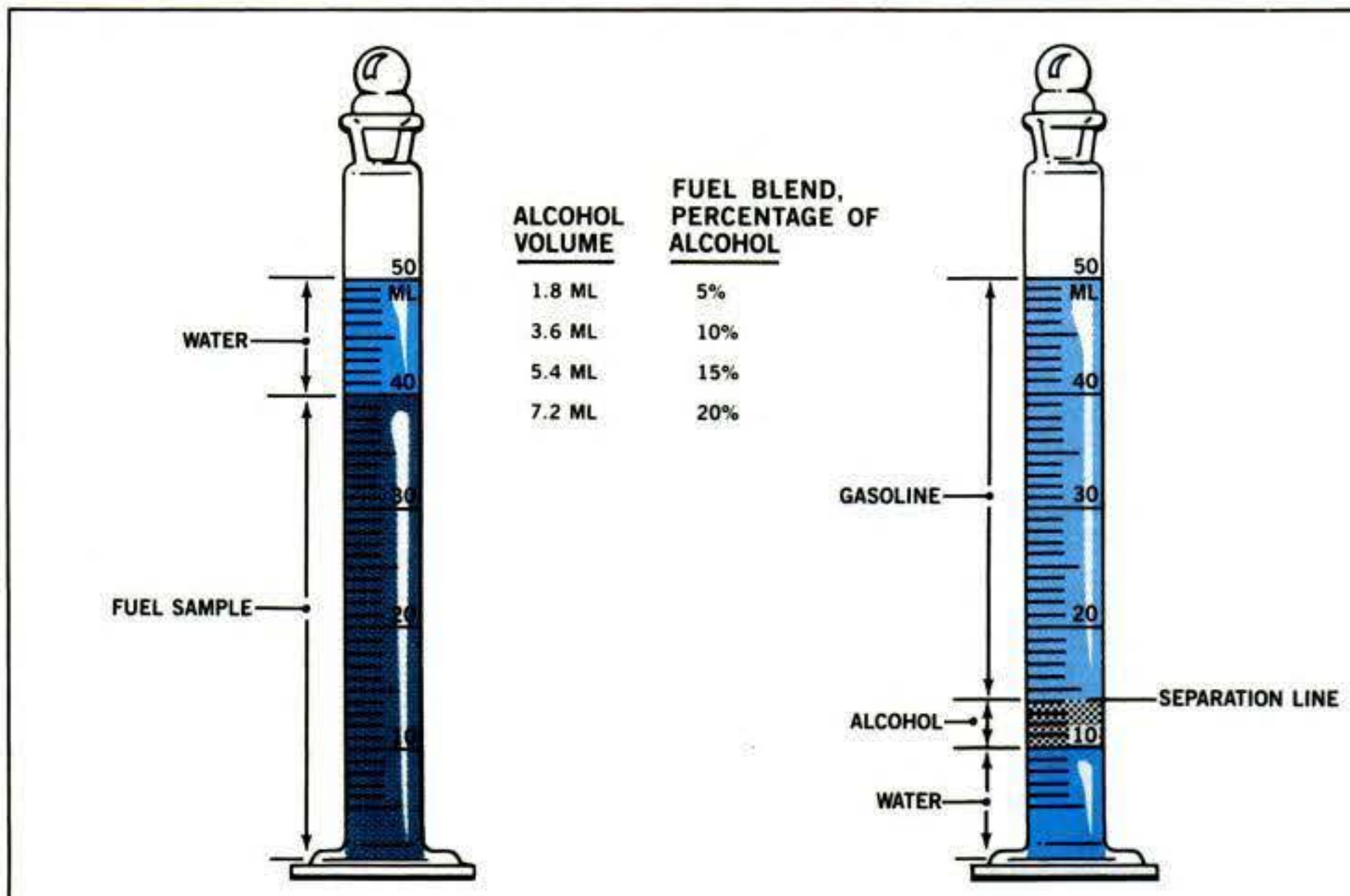
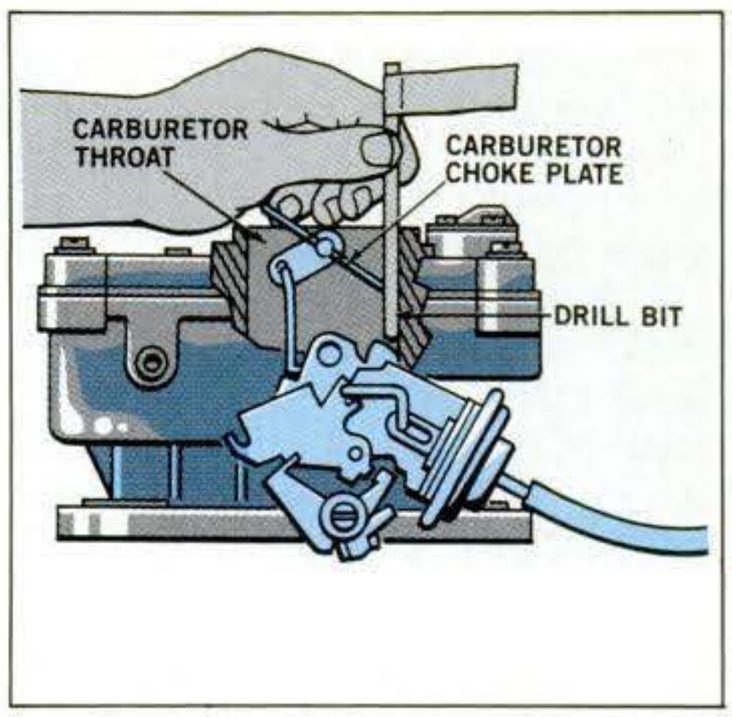
Taking Care of Your Car

By STEVE MERCALDO



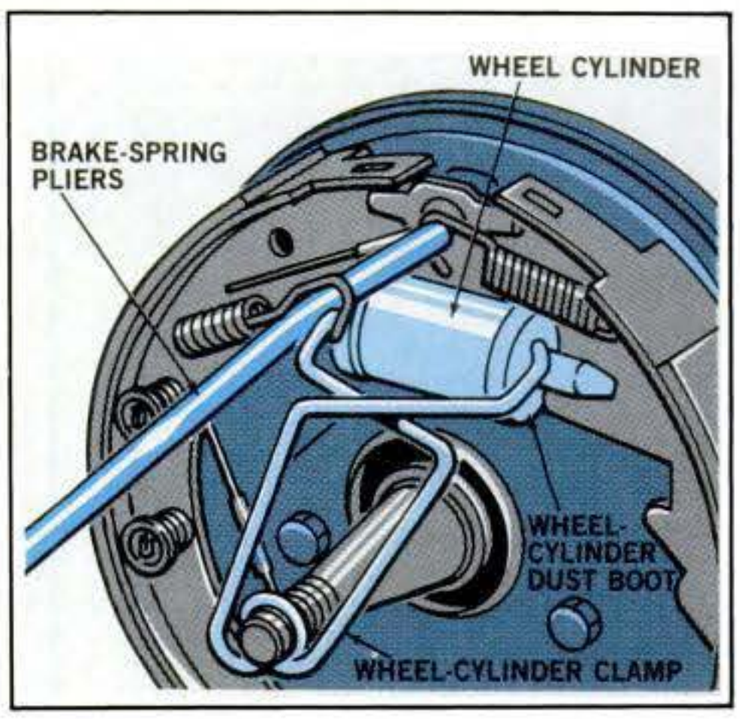
Testing for alcohol in your fuel

Drivability problems such as rough idle, stalling, and lost power can sometimes be traced to excessive amounts of alcohol in the fuel. To test for alcohol content, siphon a sample of fuel from the *bottom* of the tank. Pour 40 milliliters of this into a 50-milliliter graduated cylinder. Add 10 milliliters of water and plug the cylinder with a stopper. Shake the cylinder vigorously, then let the cylinder stand on a level surface for about five minutes. If alcohol is present, it will mix with the water, raising the separation line on the cylinder. Use extreme caution when siphoning and handling fuel.



Choke check

The easy way for mechanics to check if the choke plate is opening the specified amount is to measure it, using a drill bit of the appropriate size. Unfortunately, the easiest way for a mechanic to ruin his day is to drop that bit down the carburetor's throat. Attach a flag of masking tape to the bit to eliminate that possibility.



Clever clamp

If a brake wheel cylinder is not equipped with stop tabs on the backing plate, remember to clamp the cylinder before shoe removal. Failure to secure the cylinder usually results in the ejection of the pistons and cups from the cylinder bore. The cylinder must then be reassembled and carefully bled to remove air.

Got a useful car tip? Send it (with Social Security No.) to Car Care, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. We'll pay $50 if we use it. No tips can be returned.

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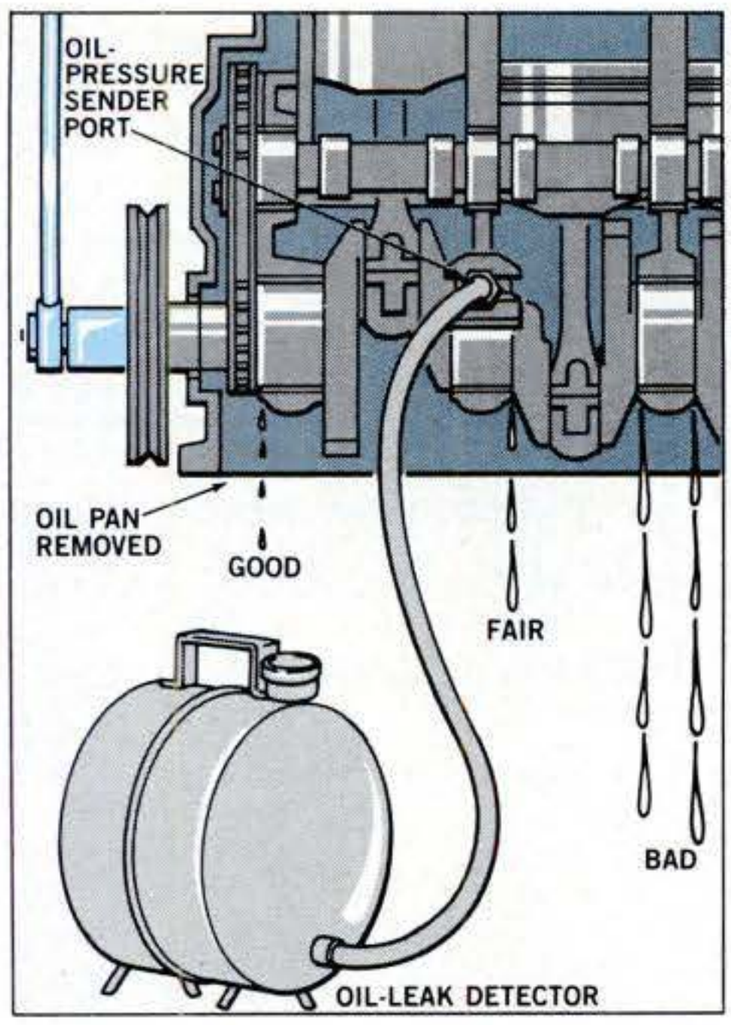

Bearing detective

Worn engine bearings are often the cause of low oil pressure. To find the bad ones, attach a leak detector filled with three quarts of oil under about 20 psi of pressure to the threaded oil-pressure sender hole. With the oil pan off, look for a steady stream of oil, indicating a worn bearing.

Hot-wheel appeal

Never apply a wheel-cleaner product to a hot wheel. After a quick drive, parts of the wheel can reach temperatures over 300 degrees F. Many wheel cleaners contain hydrofluoric, hydrochloric, and phosphoric acids, which can do extensive damage when applied to a hot surface. Use gloves, and hose the wheel down before application.

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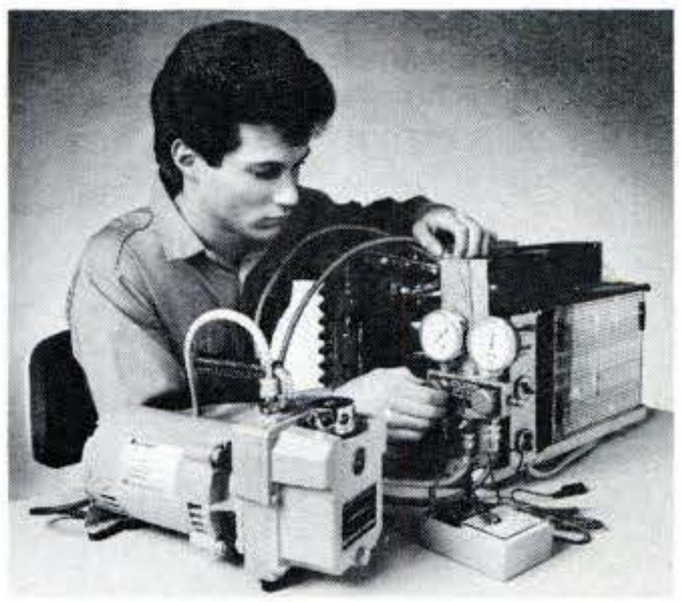

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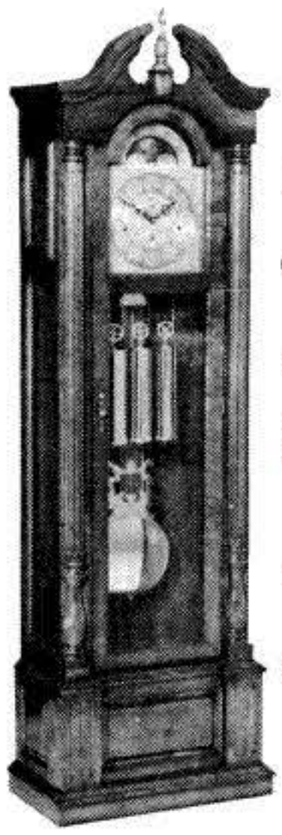

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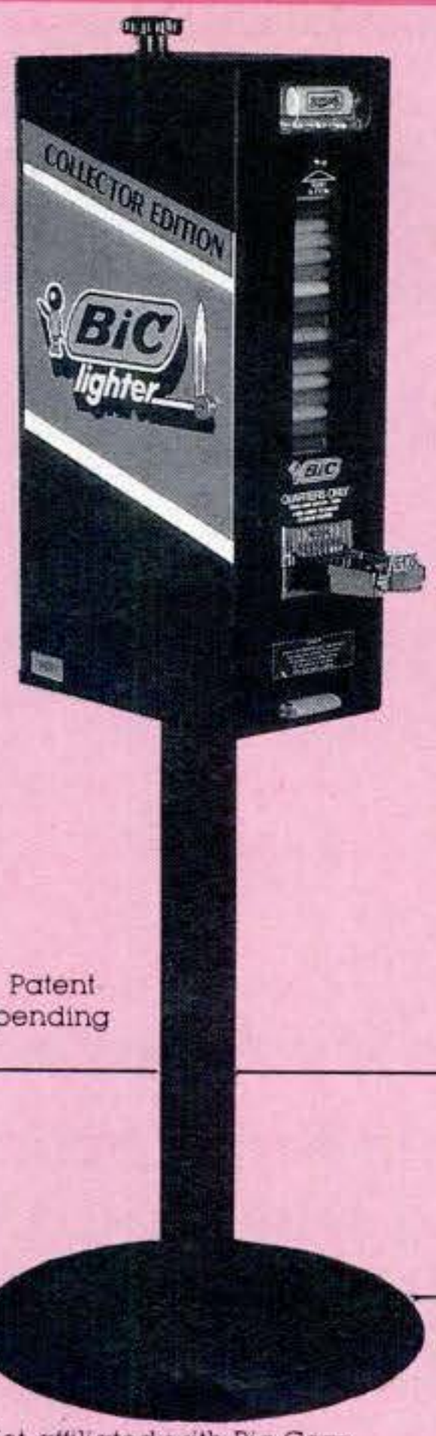

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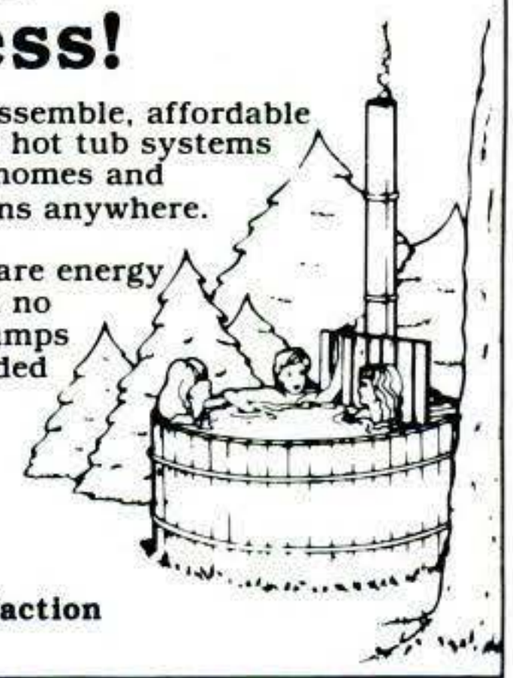

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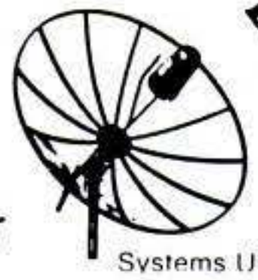

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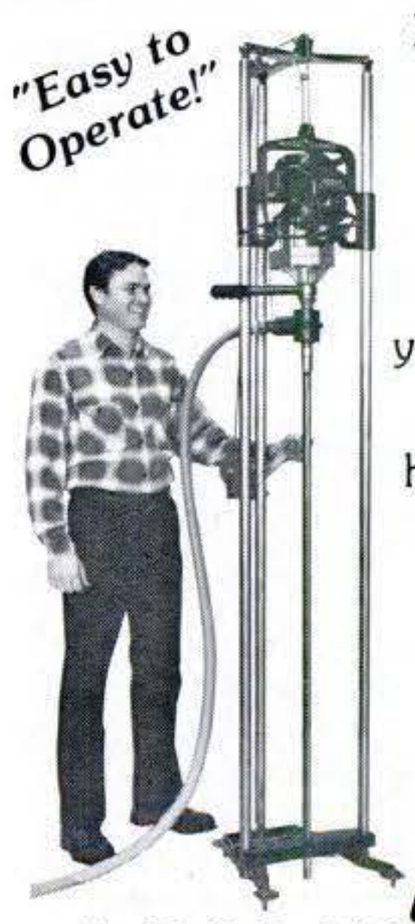

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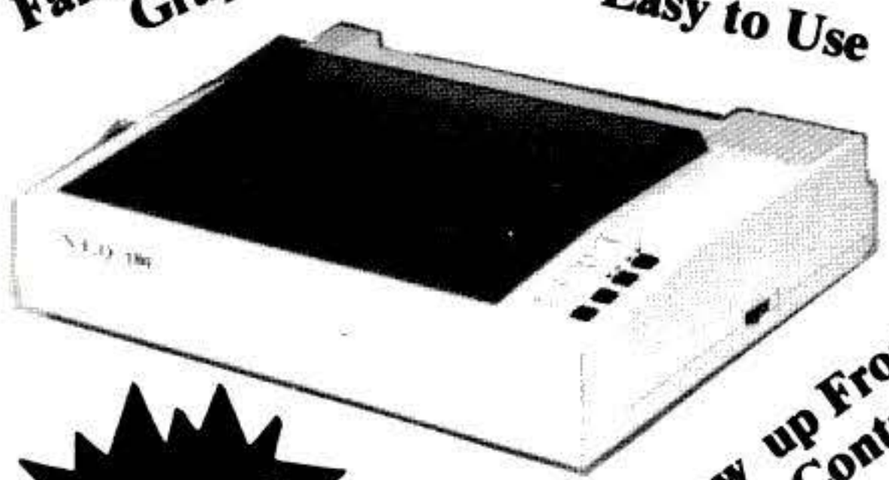

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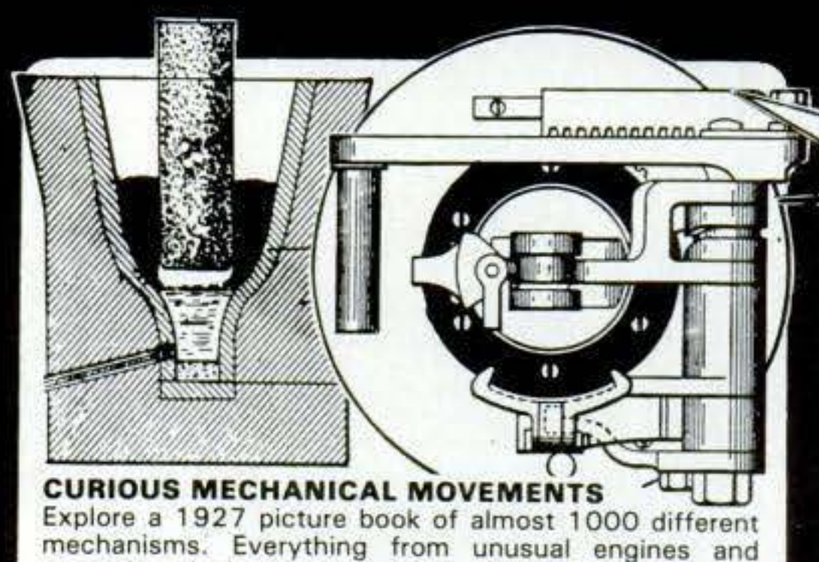

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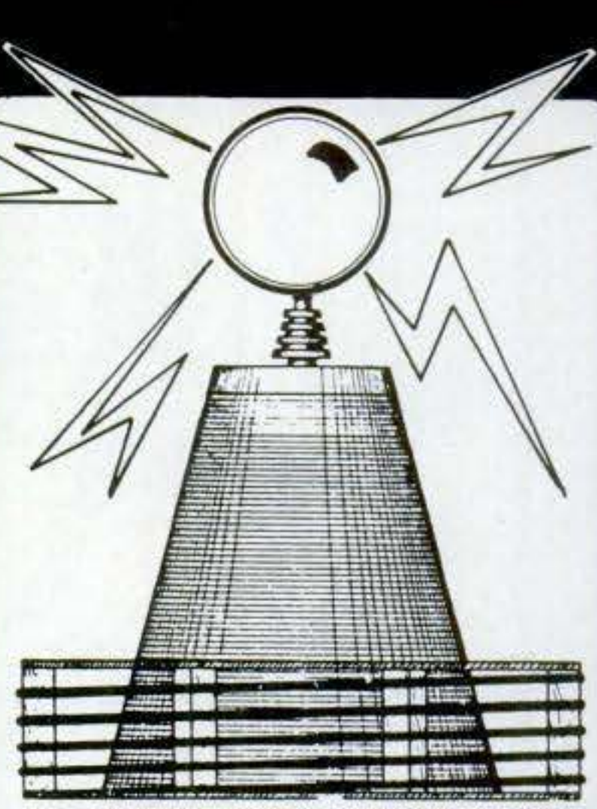

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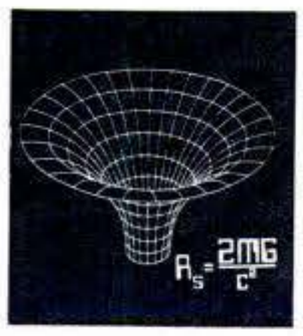

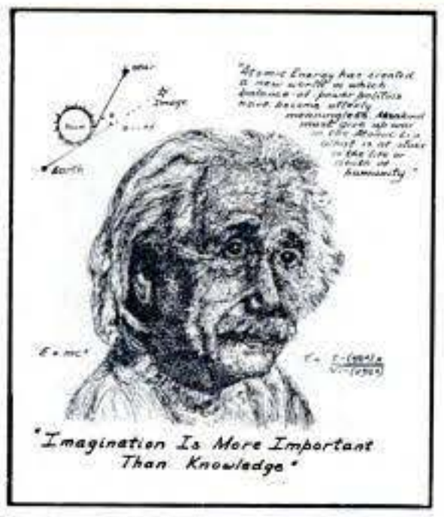

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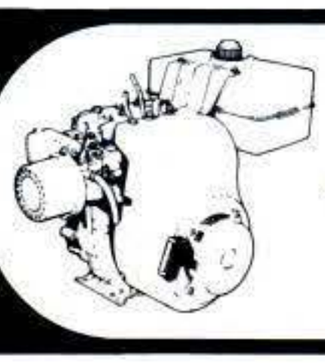

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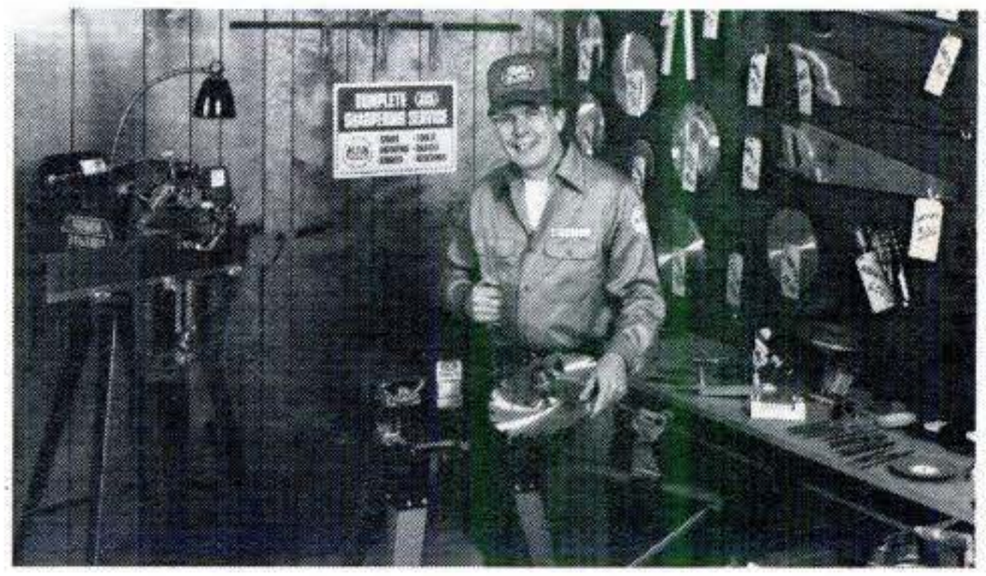

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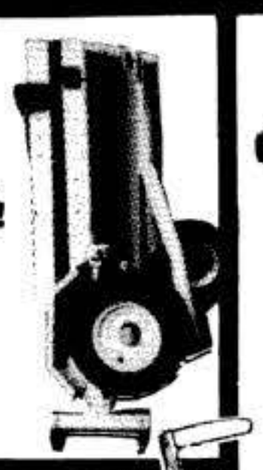

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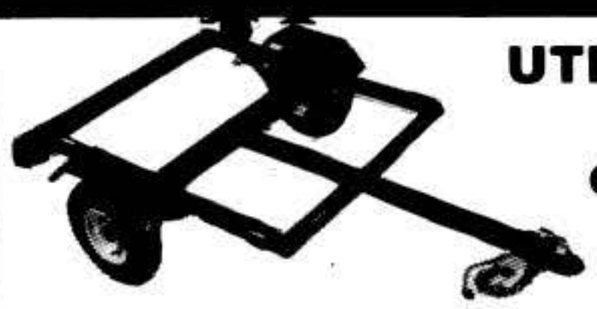

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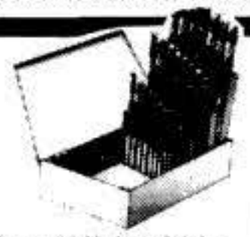

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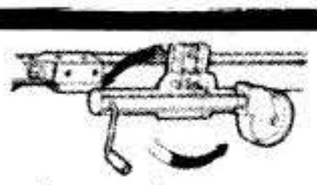

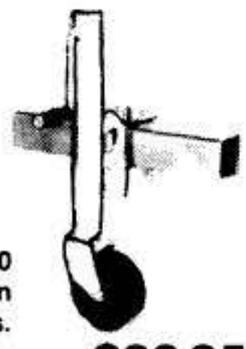

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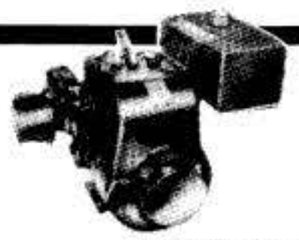

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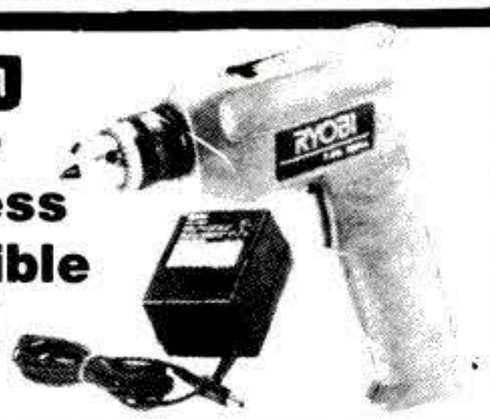

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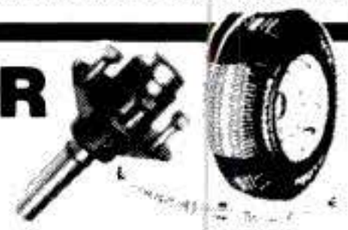

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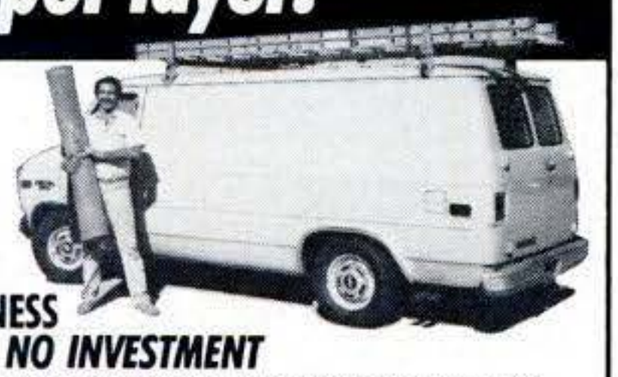

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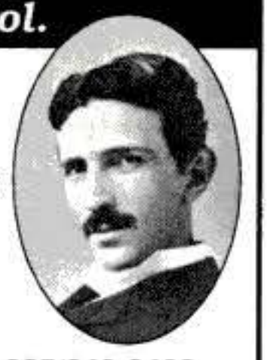

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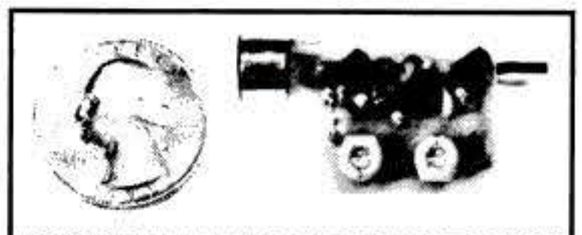

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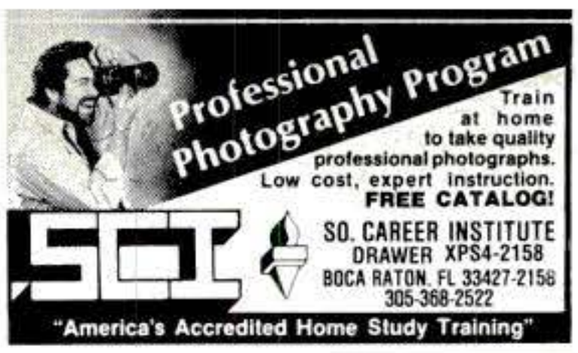

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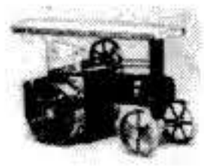

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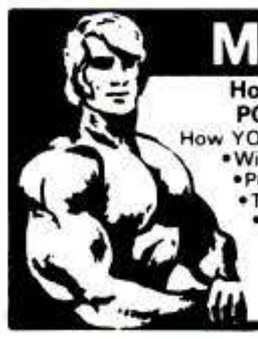

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